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ABSTRACT

These Technology Activity Modules are designed to serve as an implementation resource for technology education teachers as they integrate technology education with Missouri's Academic Performance Standards and provide a source of activities and activity ideas that can be used to integrate and reinforce learning across the curriculum. The modules take a major topical approach and include a wide range of activities from lower level to more advanced. They include the following: performance standards; activity suggestions for science, mathematics, health, communications, and social studies classes; procedures for conducting activities; and assessment sections. Instructor resource pages include some or all of the following: content outline, lists of resources, teaching suggestions, glossary, assessment suggestions, and a summary. The activities are grouped under the following subject areas: flight; space technology; telecommunications and telephony; graphic communications; bio-related technology; instrumentation and control; video production; applied physics; robotics; plastics technology; electronics; technology impacts and values; materials and processing; mass production and manufacturing; bridge building; and computer-aided drafting. (KC)

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Technology Education

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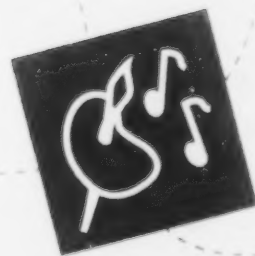
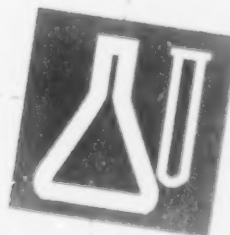
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TAM Overview

Much of the genius of our profession throughout our history (through Manual Training, Manual Arts, Industrial Arts, and now Technology Education), has been in our activity-based and practical orientation to learning. The old proverb captures it well:

Tell me and I'll forget (right after the test)
Show me and I'll remember (for awhile)
Engage me and I'll understand (empowerment)

The Window of Opportunity

We are currently in the midst of a period of tremendous opportunity for the profession.

- Other academic areas are realizing the value of applied academic activities;
- Technology Education is increasingly coming to be valued for its ability to integrate and make connections across the entire curriculum (math, science, language arts, etc.);
- Technology Education teachers possess many unique skills and expertise in some of the most exciting new areas which are impacting the curriculum (video, telecommunications, multi-media, computer graphics, space, etc.) in addition to the considerable expertise we already possess in so many other technological areas;
- The current trend around the nation is shifting away from "discipline specific" academic standards in favor of more "connected" and "integrative" approaches to learning. This shift in philosophy and practice opens a tremendous window of opportunity to the Technology Education profession to contribute to the core of the academic curriculum;
- The Goals & Performance Standards which are being developed in Missouri as a result of the Outstanding Schools Act of 1993 are highly integrative and multidisciplinary. It is possible that Technology Education will be able to contribute to the core of general education as perhaps never before.
- Across the nation, there is a swelling demand for Technology Education teachers.

The new set of Technology Activity Modules (TAMS) which were developed for this Performance Based Education project were specifically designed to assist Technology Teachers in moving into this window of opportunity.

Features of the Performance Based Education TAMS

These new TAMS are the result of many factors. They reflect the good thinking and feedback received from many of our Technology Education teachers, input from advisory committee members, hours of hard work by TAM writers and field testers, and the creative touch of our design team. Above all, the attempt was to develop a usable, activity-rich package of materials which are carefully grounded in Performance Standards and connected with other academic areas. Specific features include:





- a major topical approach rather than a single activity or technology cluster emphasis (for example graphic communications, bio-related technology, flight, space, etc.),
- a set of Performance Standards designed to cover each of the topics (designed to parallel Missouri's Performance Standards),
- plans of procedure for numerous Technology Education activities (most TAMS have 4-6 developed activities including materials lists.),
- Icon-based Integrated activity suggestions, woven throughout the TAM activities (science, mathematics, health, communications, and social studies),
- suggestions for additional Technology Education activities,
- a wide range of activities (from lower level to more advanced),
- a sample scoring rubric designed to weave together the broader goals of all of education, the TAM's performance standards, and specific observable behaviors/knowledge for a selected TAM activity,
- additional assessment items (TechFolios, performance checkoff lists, product checkoff lists, etc.),
- an instructional resource section.

Important Implementation Notes

- It is extremely important that activities be grounded in objectives and Performance Standards. **It is critically important that we be able to clearly identify what it is that the activities are contributing to the growth and learning of our students and that our goals and objectives be linked with the Missouri's State Goals and Performance Standards** (see the Competency Articulation section of the Performance Based Education Handbook, pp. 6-15).
- A number of different types of assessment items have been included in the TAMS. These should be viewed as samples of the kinds of items which can and should be developed for other technology education activities rather than as a comprehensive assessment of any single TAM. You are encouraged to use the many sample assessment items which are presented in the TAMS and in the Handbook as a bank of ideas which you can use to develop additional assessment tools of your own. Remember, we who are in the Technology Education profession have a long history of using many of the kinds of performance and product assessment tools which are currently attracting interest across other academic areas.
- Each TAM contains a SAMPLE scoring rubric for one of the TAM's activities. These are specifically designed to tie identifiable and observable student behavior directly to the TAM's Performance Standards as well as to a larger set of goals for all students (creative thinker, critical thinker, contributing citizen, etc.). Again, these should be viewed as samples. You are strongly encouraged to "plug in" the observable behaviors that you judge to be evidence of student performance at the 3 levels in the rubric structure.
- Many additional activities can and should be developed to address each of the TAM's topics. It is hoped that you would continue to supplement the activity base presented in these TAMS with your own ideas and procedures.
- Many integrated activity ideas have been "seeded" throughout the TAMS. Certainly there is no way that these could capture all of the possibilities. It is hoped that these will serve to stimulate your thinking and reinforce the tremendous importance of connecting with other academic disciplines. We need the other disciplines. . .AND THEY NEED US!



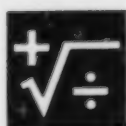
Lighter Than Air!

Goal

The goal of this TAM is to introduce the student to the basics of aeronautics, aerodynamics principles, and flight and to provide hands-on experiences in building, flying, and testing various types of aircraft and equipment relating to aeronautics.

Performance Standards

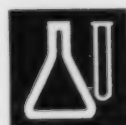
- Be able to gather, solve, understand, analyze, and apply information related to flight technology.
- Identify the basic motions of aircraft in flight.
- Assume roles related to positions in the aeronautic workforce, (i.e., production worker, inventor, layout designer, foreman, etc.).
- Use the scientific method to determine results of experimentation.
- Locate and determine the center of balance for a glider.
- Be able to name and locate parts of a plane.
- Comprehend and solve simple and complex mathematical problems used in aeronautics.
- Be able to effectively communicate the four forces acting on an aircraft.
- Determine the most effective aerodynamic shape of flight.
- Be able to manipulate and operate related technology to perform given tasks.
- Be able to name and locate parts of a plane.
- Know and be familiar with terms relating to aeronautics and aircraft.



Mathematics



Communications



Science



Social Studies



Fine Arts



Health



Technology



Introduction

Since the dawn of time people have tried to fly. Many have tried and failed as the technology has quickly improved from several second record-breaking flights to today's daily trans-Atlantic jaunts. Many still find it hard to believe that an object weighing more than your home could actually get off the ground much less fly around the sky. Flight truly has a fascination for all.

This TAM's purpose is to introduce students to flight, its properties and terminology, and to truly understand how it is possible for a plane to move about in the sky. This TAM will provide activities in glider building, wind tunnel testing, paper plane/mass production, flight simulation, powered model airplanes, and hovercrafts.

Objective Statement

The activities described in the following pages represent samples of activities which can be used to deliver the performance standards on page 1. Many additional activities can and should be used. Extreme care should be taken to connect each activity with appropriate activity objectives as well as with the above performance standards. These objectives should be developed by the instructor and should be shared with and made clear to the students.

Activity 1

Paper Planes

Ever since most of us were small children, we've made paper planes. Usually it's been purely for the fun of it. This activity will also be fun, but it will go further into examining some basic principles of aerodynamics and flight. This activity will involve the designing, making and testing of a paper airplane. This will happen in "companies" which the students will establish.



Integrated Activity Idea

Have social studies/ geography teacher teach latitude and longitude. Use it to read aeronautical charts.



Integrated Activity Idea

Calculate width/depth/ length ratios for the planes and compare to flight length.



Technology Idea

Build a hot air balloon using tissue paper.

Procedure

1. Divide class into groups of 3-4.
2. Have each group pick a name for their company.
3. Decide whether you want students to build for distance or loft time (tape measure or stopwatch).
4. Begin letting students build experimental planes and test in the room (keep track of all sheets of paper used, you may want to number sheets to keep track better).
5. When students have their design they must then draw-out onto their patent sheets a sketch including all folds. If all in the group do it, pick the best to turn in.
6. Once drawn, patent sheet and one model plane must be turned in and checked for accuracy by the teacher.
7. Once a patent is granted, it cannot be duplicated by another group.
8. Set up a mass production run to produce 10 "planes." Develop jigs and fixtures to assure that they are exactly alike.
9. When planes are complete, flying can begin indoors or out.
10. Choose a starting point, watch for scratches (over line).
11. Have one from each group record distances or time for all 10 planes.
12. Add, and divide by 10 for average distance or hang time, depending on the criterion chosen.
 - What designs developed the best hang time? Why?
 - What designs covered the best distance? Why?
 - What real world models are there for the principles you discovered? (Stealth Bomber, 747, birds, etc.)
 - Based on the other groups' patents, what would you try if you did the exercise again?



13. Spend time debriefing the experience. Have each company prepare a technical report including design criteria, drawings, test results, analysis of results, improvement suggestions, etc.

Student Parameters/Rules

- Paper costs per sheet (i.e.: \$10,000, per sheet - keep track).
- Each group must draw a sketch (rough) onto patent sheet for approval which must be accompanied by model.
- Name of plane must be on patent sheet.
- Construction can begin only after patent is approved (mass production is encouraged). 10 must be completed exactly alike.
- Planes not matching patent model will be rejected and must be rebuilt (thus more money \$\$\$).
- Only one person from the group will be allowed to throw the planes from each group (can't be changed once chosen).



Technology Idea

Locate photographs of a number of airplanes. Compare these with the various paper plane designs. What do the comparisons tell you about the success of features of the paper plane designs?

Materials Needed

1 copy of aeronautic patent per student
1 pkg. of ditto-type paper
100 ft. tape measure

1 ruler per group
stopwatch (optional)



U.S.Y. Patent Application

United States of Yates Patent Office

As a below named inventor, I hereby declare that:

I am a member of the class as stated below.

I believe I am the original, first, and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled _____ the specification of which is attached hereto.

I hereby declare that all statements made herin of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by loss of credit for project, or referral to the Hall Principal, or both, under articles of the Student Handbook and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor: _____

Inventor's signature _____ Date: _____

Class Name: _____ Hour: _____ Location: _____

Citizenship: _____

Attach appropriate drawings to completely describe your invention.

■ Adapt as Necessary.

■ Contrucubed by Ben Yates (Columbia Public Schools).

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Activity 2

Unpowered Gliders

This activity is designed to take the principles learned in the construction of the paper plane models a step further.

The glider in this activity can be made from balsa or styrofoam sheets. Use rubber cement for the styrofoam and white glue or model cement for wood or balsa. When gluing the styrofoam with rubber cement, apply cement to both matting surfaces. Allow the cement to dry until it is no longer tacky. Carefully press the surfaces together.

Be careful to get it aligned the first time. There is no second chance. Once stuck together, they cannot be moved. No extra fillets of glue are needed for rubber cement on styrofoam.



Integrated Activity Idea

Write a report on some aspect of the history of aircraft. One approach could be to focus on people such as Lindbergh, Earhart, or the Wright Brothers. Another approach would be to trace the development of power systems. You could also explore the evolution of wing shapes and configurations.



Integrated Activity Idea

Talk with the science teacher about the students using the scientific method of experimentation and use the same way to record results in class testing.

GLIDER ASSEMBLY

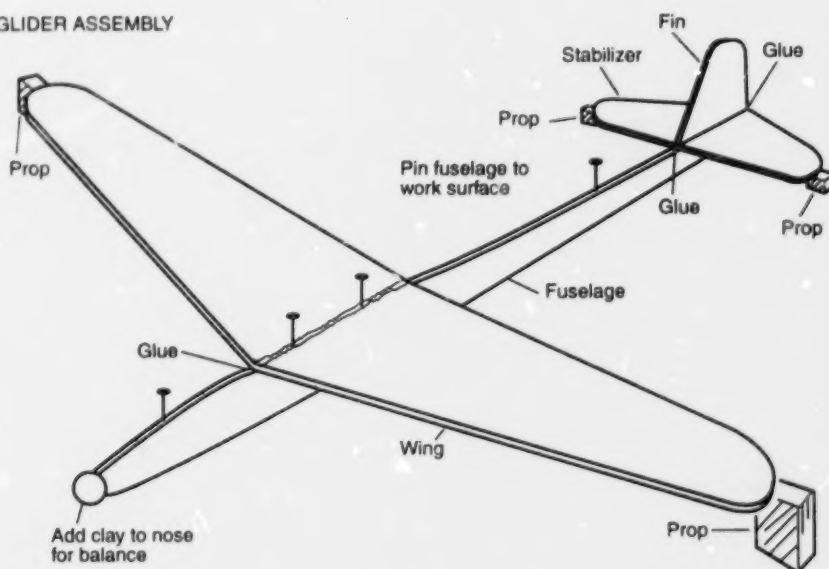


Figure 1 - Glider Assembly



Procedure

1. Construct the fuselage. The fuselage can be a straight stick. In this design the shape of the fuselage has little effect on the performance of the glider. Excess material has been cut away. This reduces weight and improves the appearance greatly. First, rough the fuselage with a knife. Then sand all surfaces smooth. Note the cross sections A-A, B-B, C-C, D-D, indicating the shape of the fuselage in those areas.
2. Construct the wing. The wing could be a flat, rectangular piece of balsa or styrofoam. But, such a boxy shape would look rather crude and not fly well. Using 1 mm (1/16") sheet balsa, shape the wing as shown.

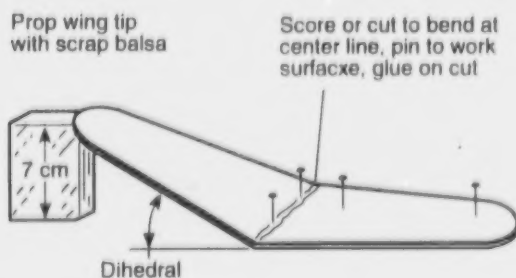


Figure 2 - Dihedral Gluing

Score the sheet on the center line with a knife. Do not cut through. This light cut will make the wing easier to bend.

Though the glider will fly with a flat wing, it will be more stable if there is dihedral in the wing. Dihedral in a wing means that the wing is not flat, but the wing tips are raised. To put dihedral in the wing of your glider, lay one half of the wing on the work bench. Bend the wing on scored center line. Raise the other wing tip 7 cm (2 3/4") above the bench.

Place a block or prop under the wing tip to hold it in this raised position. Put glue on the scored center line. When dry, the glue will hold the wing in the proper position, until it can be glued to the fuselage.

4. Construct the stabilizer and rudder. The stabilizer and rudder are simple flat sheets. They provide the tail surfaces needed for control of the glider. Cut from 1 mm (1/16") to shape shown.
4. Do the final assembly. Begin by pinning the fuselage to the work surface. Be certain the fuselage is pinned down flat. The bottom of the fuselage must be flat on the work board. Put glue on the wing and pin it in place on the fuselage. Use glue liberally. Some glue should squeeze out from the wing mount area.

Carefully align the wing. Place props under each wing tip. The wing tips should be the same distance from the work surface.



Integrated Activity Idea

Science question: gravity, what is it? What is meant by center of gravity and how is it determined in aircraft?



Technology Idea

Call or visit a local airport and see if glider or ultralight flights are available. While at the airport arrange to visit with a number of different people to explore information related to career possibilities (aircraft maintenance, pilot, security operations, customer relations, weather tracking, etc.).



Technology Idea

Following state expo guidelines, develop a payload glider. You can also hold a paper airplane competition in the gym, judge for accuracy and distance.



Integrated Activity Idea

Examine the product specifications sheets of the model airplane dope and the glue to identify potential health risks.



Technology Idea

Use a windtunnel to test the plane and then predict the results.

The rudder is added on top of the stabilizer. Apply glue to the bottom of the rudder and put in place. Pins may be used to hold the rudder in place until the glue dries. Be sure the rudder is perpendicular to the stabilizer. Props may be needed to hold the rudder in position until the glue dries.

When the glue is dry, all props and pins can be removed. Remove the glider from the work board. Add an extra fillet of glue to strengthen the joints.

5. Make the final adjustments. Proper balance is needed before the glider will fly. Try flying your glider without balancing it. What happens? It probably flutters about like a falling leaf.

Add some modeling clay to the front of the fuselage. Add enough to balance the glider at the point shown. This is usually about one third to one half the width of the wing back from the leading edge.

Now test fly the glider. It flies better, doesn't it! If correctly balanced, it should glide away from you for a long distance, slowly gliding down to a soft landing. If it rises into a stall then dives, add a small amount of clay to the nose. If it glides only a short distance and dives to the ground, the nose is too heavy. Remove a small amount of clay.

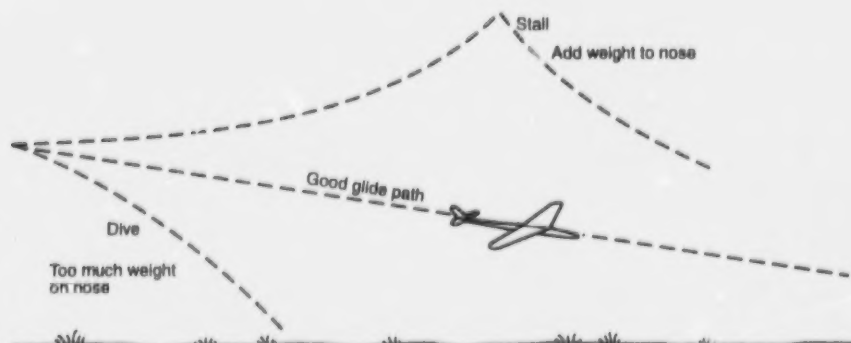


Figure 3 - Test Flight Adjustments

6. Decorate the glider. You can improve the appearance of your glider by adding decorations or painting it with model airplane dope. Use colored marking pens. They will mark directly on the balsa or styrofoam.

For a really sharp looking model (balsa only) you can apply several coats of model airplane dope. Sand lightly between coats. The first coat will feel rough when dry. Sand lightly to remove stiffened wood fibers. Apply the second coat of dope. It should not have to be sanded. You can then further decorate using several colors of dope or decals.

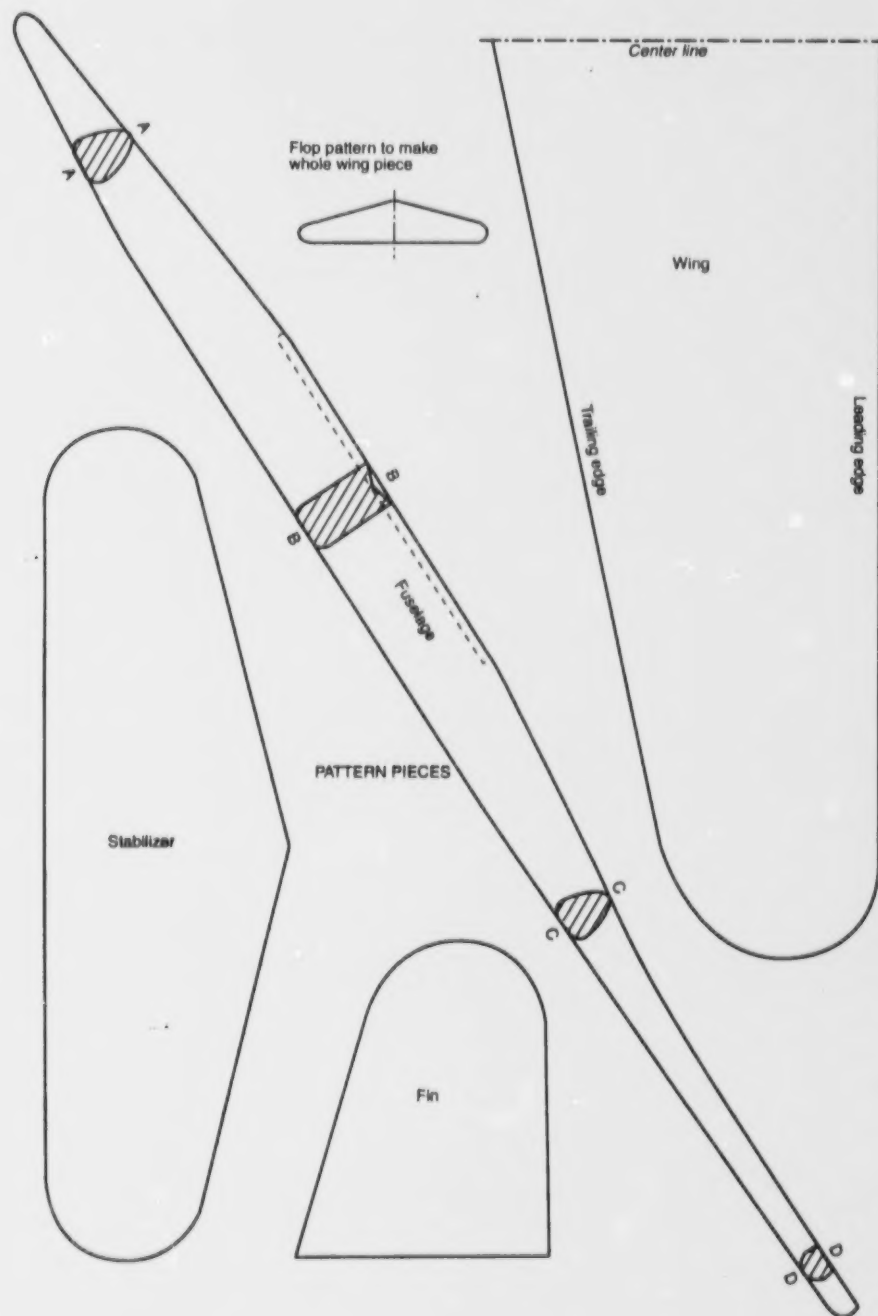


Figure 4 - Templates

The template shown is 75% of its original size. You will need to enlarge it to 125% on your copy machine.

Going Further

The glider constructed in this activity is one of the simplest designs you can make. That's why it was used as a beginning activity. You can make many changes in the design of it that will improve performance. For example:

- What happens when the wing is made smaller or larger? Longer or shorter? More narrow or wider? What happens when the wing is moved forward or backward on the fuselage? What if you use a biplane design?
- The wing of this glider is made from a flat sheet. Performance can be improved by adding an airfoil wing, (a curved wing). Try constructing the wing from a thicker sheet and then curving the surface of the wing. What do you predict will happen?
- What happens if a flat wing with no dihedral is used? Does this affect the performance of the glider?
- The glider can also be made with differently designed wings. A polyhedral wing should make it more stable. Make a glider of similar size with a polyhedral wing. Does it fly differently?

	Distance	Stability	Speed
Lengthen wing			
Shorten wing			
Widen wing			
Narrower wing			
Curved wing			
Polyhedral wing			
Biplane design			

Materials Needed

balsa sheets various thicknesses (1/16"-1/8") wings/tail/stabilizer

balsa strips or styrofoam (3/4"-3/8" or 1/4" square)

modeling clay

x-acto knife

extra-fine grit sandpaper 200-400

straight pins

rubber cement

model airplane dope

NO MONEY?- Use a pencil and cardboard for the fuselage and wings



Activity 3

Wind Tunnels

Wind tunnels are used for a wide variety of testing situations where the aerodynamics of a product are important. Automotive designs, wing shapes, various surface finishes, and much more are tested for their aerodynamic properties. In this activity, you will build and use a wind tunnel.

1. Measure window fan to determine its outside dimensions.
2. Build a frame large enough for the fan to just slide into the opening (about 1/8" clearance).

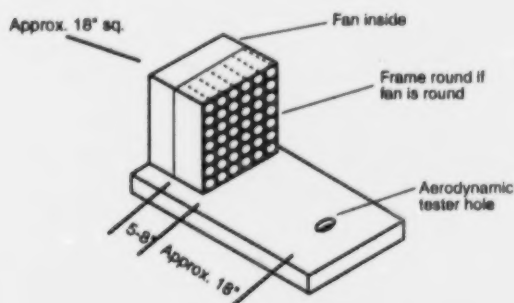


Figure 5 - Fan Frame Setup

3. Glue tubes together (do not crush) and into frame at far end opposite the fan opening (see Fig. 5).
4. Mount to plywood base with screws.
5. Build one or more of aerodynamic testers (see Fig. 6). [See TAM #1 Flight Technology and Aerodynamics (Steve Murray) 1991 Workshop Series for wing tester if desired.]

Additional wing shapes

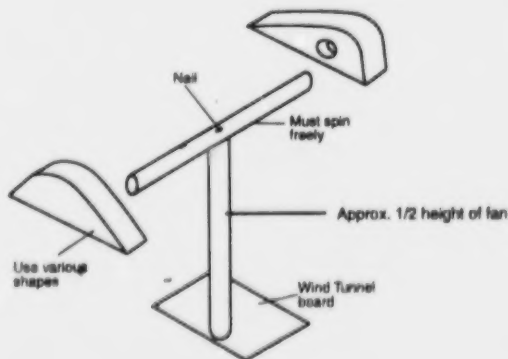
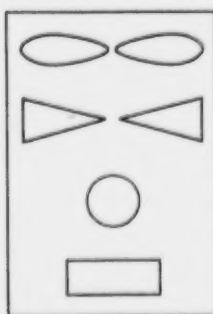


Figure 6 - Aerodynamics Shapes Comparer



Technology Idea

Use your imagination: use wind tunnels for CO₂ cars. Add smoke, use streamers to show air flow, etc.



Integrated Activity Idea

Write a report on changes the automotive industry has made in automotive design as a result of an emphasis on aerodynamics.

6. Place coins on wing shapes to determine lift capabilities (use various weights i.e. coins-see Fig 7).

Test Weights

If a set of laboratory weights are not available the following approximate weights can be used. (Be sure that the coins are new)

 Dime = 2.2 gms.

 Penny = 3.1 gms.

 Nickel = 5.0 gms.

 Quarter = 5.7 gms.

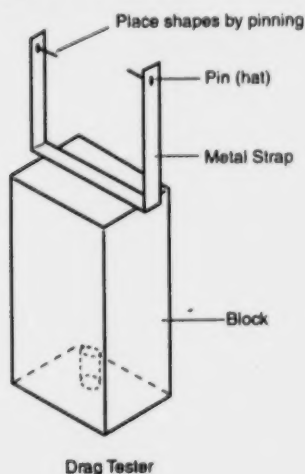


Figure 7 - Drag Tester

Materials Needed

Fan of any size
 Toilet or paper towel rolls (amount varies to size of fan)
 Piece of plywood approx. 2' x 6' (base)
 Frame for tube (wood or cardboard)
 Screws to attach tunnel to board
 Various parts (see diagrams for aerodynamic testers)



Activity 4

Flight Simulation

The computer has become an important tool for a number of different modeling applications. Computers are used to model robotic end effectors, automate designs, rocket trajectories, interior designs, investment strategies and lots more.

You might ask, "What's the value of computer models?" Why not just build the "object" or engage in the activity and then use the computer to analyze the results? Companies have found that the dollars and time invested in computerized modeling for design and training (for example in training pilots) pays off enormously in dollars, and maybe in lives saved.

In this activity you will use a computer simulation to "experience" and learn some of the basic principles of flight. Have fun!

Procedure

1. Place disk into computer and boot.
2. Have students work in pairs taking turns and advising one another as they work the controls.
3. Spend some time getting familiar with the instrumentation provided with the software. (Airspeed Indicator, artificial horizon, altimeter, turn coordinator, directional climb indicator, magnetic compass, etc.).
4. Start take-off procedures (follow manual guidelines).
5. Once in the air have students attempt and perform some basic moves such as:
 - ◆ roll
 - ◆ pitch
 - ◆ yaw
 - ◆ stall
 - ◆ landings
6. Have students experiment with acceleration during each of the movements above and tell their effect on flight.



Integrated Activity Idea

Make a tape of songs that mention aircraft i.e. Leaving on a Jet Plane, Coming in on a Wing and a Prayer, etc.



Technology Idea

Make a video using some "old footage" of early flight attempts and some old aircraft as well as some footage of modern flight. Overlay appropriate music.



Technology Idea

Organize a software "airshow" to see who can accomplish the highest number of complex air maneuvers. You could also go to a real airshow, capture the moves on video and then perform them on your simulator.

7. Experiment with various acrobatic procedures which are available with your software. These may include:

- ◆ spin
- ◆ loop
- ◆ aileron roll
- ◆ inverted flight
- ◆ split S
- ◆ Immelman
- ◆ hammerhead

8. Experiment with different types of aircraft, if available on the software.

Materials Needed

Microsoft FLIGHT SIMULATOR, Mac/IBM

GLIDEPATH, Apple (Available: Trans tech, Pitsco, Hearlihy,* Best Buy)

*Best Buy = \$25.00 cheaper than catalogs and has sound and graphics update available for \$23.00



Activity 5

Line Powered Model Airplanes

The Wright brothers were the first people to build and fly a powered, heavier-than-air craft. They were able to put a lightweight engine in an airplane. They also developed a system of controls so the airplane could be steered through the air. The modern airplane has developed from this rather simple beginning in 1903.

Outdoor flying includes several kinds of powered airplanes. Rubber-powered or engine-powered models are designed to stay aloft as long as possible. The engine-powered models contain a timing device that cut off the engine after a preset time. The model climbs rapidly as high as possible. When the engine stops, the model glides slowly back to the earth. In competition, the object is for the model to fly as long as possible.

Control-line airplanes are flown in a circle around the pilot. Lines are connected to a control system in the model. Through these the pilot can cause the plane to climb, dive and do stunts. Competition with the U-control models includes fly speed, stunt, combat or races between several airplanes. Some control-line airplanes have retractable landing gear and working control surfaces.

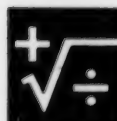
Radio controlled (R/C) model airplanes are becoming extremely popular. As the radio equipment becomes more complex, the models can be better controlled. Sail planes can be kept aloft for long periods of time. Aerobatics can be flown much as done in full-sized airplanes. Several R/C models can be flown in races around pylons set up as a race course. Scale R/C models are built to such an exact scale that a photo of a model is difficult to tell from a photo of the real airplane.

As a first activity here, you can build a simple U-controlled model. This specially designed model can be built in just a few hours. It is easily flown and easy to repair after a crash. This makes it a good trainer.

Procedure

Wing Construction

1. Transfer the design for the wing ribs onto 1/16" sheet balsa. (See page 24 for templates.)



Integrated Activity Idea

How fast is an F-15 traveling if it is flying mach 3, if mach is equal to 1760 mph?



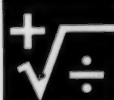
Integrated Activity Idea

Prepare and deliver an oral report on the basic applications of R/C. Include some neat potential future uses of the technology!



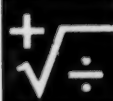
Technology Idea

Use test results from wing shape testing in Activity 3 to customize the wing shape for this activity.



Integrated Activity Idea

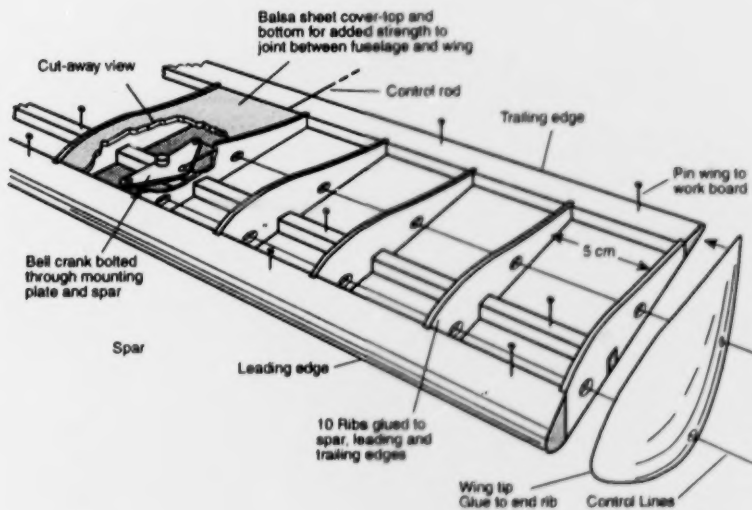
Determine the time needed to fly around the world at a given speed. Include real life aeronautic variables such as trade winds and various routes used for international flight.



Integrated Activity Idea

Interview a flight mechanic, find out the weight of a commercial jetliner and its payload capacity. When is there too much luggage to lift off?

2. Carefully cut 10 ribs. Cut holes on one-half (5) ribs for the control lines to pass through. Cut the 1/4" notches for the spar.
3. Cut the spar and leading and trailing edge stock to lengths. Leading edge can be made from 1/2" square balsa or from preformed leading edge stock. Trailing edge can be made from 1/4" x 3/4" balsa strip or preshaped trailing edge stock. Beginning at one end, make marks 5 cm apart the full length of each piece. These marks will indicate the positions of the ribs. Cut the notches in the leading edges for the ribs. Do not cut notches in the spar.
4. Pin the spar down onto the workboard. Place the ribs in the position over the spar. Put the ribs into the notches in the leading edge. Pin the leading edge to the plan. Be sure all parts are in proper position, square and proper alignment. (See Fig. 8 - Wing Construction Detail.)
5. The ribs with the pass-through holes for the control lines are put in the left half of the wing.
6. Cement the ribs to the leading edge, trailing edge, and the spar. Allow the glue to dry completely.
7. When the glue has dried, remove the wing from the workboard. Put a second coat of glue on all joints.
8. Cut wing tips from 1/4" square balsa. Cement them into position. Pins can hold the wing tips in position until the glue dries.
9. Shape and sand the leading edge, trailing edge, and wing tip blocks to proper shape.
10. Cut the bell crank support from 1/16" hardwood model-makers plywood. Cement in place. Let glue dry. Drill a hold through the mounting plate and wing spar for the bell crank mounting bolt.
11. Mount the bell crank in place.
12. Attach the control lines to the bell crank and pull through the holes in the wing ribs. The line should extend about 1/2" beyond the wing tip. The left wing tip may have to be drilled or notched to give space for the control lines to move freely.
13. Connect the control rod to the bell crank.
14. Cover the top and bottom of the center wing section with 1/16" balsa sheet. Cement well, applying two coats of cement to all joints. A notch must be cut in the top cover plate to allow the control rod to pass through.
15. Test the controls. The bell crank and control rod should move easily and freely when the control lines are pulled.



Integrated Activity Idea

Develop a time line showing the history of aircraft.

Figure 8 - Wing Construction

Fuselage

1. Cut the fuselage from 1/4" balsa sheet. Transfer the pattern to the balsa and cut with a sharp knife. Carefully cut the notch for the stabilizer and the opening for the wing.
2. Trial fit the wing in the wing opening. Trim the opening until a close fit is obtained. Shape and sand the fuselage.
3. Cut the engine mount from sheet aluminum. Drill holes and bend to shape. Drill holes in the fuselage. TRIAL fit both halves of the engine mount in place with bolts. Do not attach the engine mount permanently at this time.

Rudder



Technology Idea

Develop and build a parachute dropping device for your line-controlled airplane. Score for accuracy.

1. Cut the rudder from 1/8" sheet balsa. Cut and sand to proper shape. The leading edge should be rounded. The trailing edge is shaped to a knife edge.
2. Cut the rudder into two pieces as shown. Bevel the edges slightly and reglue with rudder offset to the right about 2 cm. Allow the glue to dry.
3. Cement the rudder to the fuselage. Be certain it is vertical. Hold it in place with pins until the glue is dry. Put a second coat of cement on the joint.

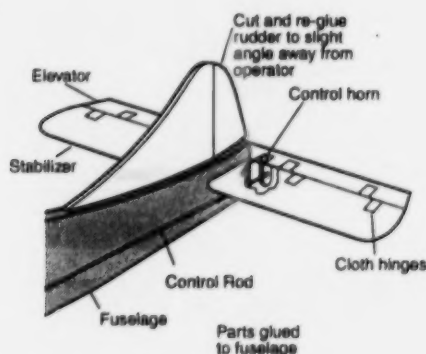
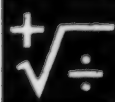


Figure 9 - Rudder and Stabilizer

Landing Gear



Integrated Activity Idea

Talk to the math and physics department about the many formulas pertaining to aircraft (velocity, thrust, distance, airspeed, acceleration, stall speed, crosswind adjustments, altitude, etc.).

1. Bend the music wire for the landing gear as shown on the plans. Put the wheels in place. Bend up the ends of the wire to hold the wheels in place.
2. Locate the attachment location by referring to Fig. 10. It is the groove in the aluminum engine mount.

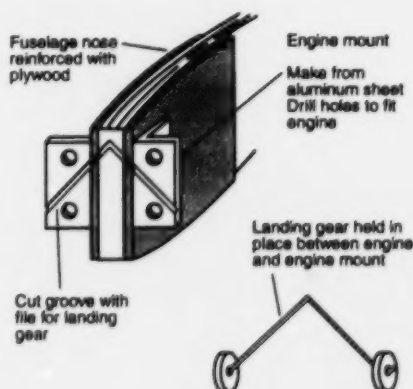


Figure 10 - Engine Mount



Assembly

1. Insert the wing into the wing opening in the fuselage. Align the wing so it is square to the fuselage. The push rod should be extending along the right side of the fuselage.
2. Cement the wing in place using heavy coating of glue. Let glue dry. The top and bottom plates in the center wing section give good gluing surface for maximum strength.
3. Put the front half of the stabilizer in place and glue. The stabilizer must be parallel to the wing. Apply a second coat of glue to all joints.
4. Put the control horn in place on the rear half of the stabilizer (the elevator). Cut the push rod to length, bend the end, and put in the hole in the control horn. Glue the hinges to the elevator and stabilizer as shown in the plans.

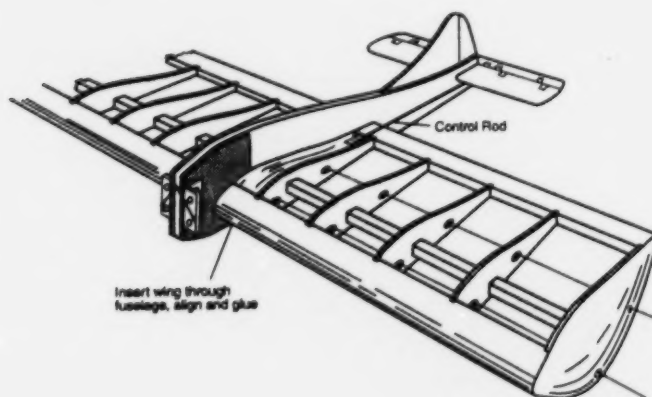


Figure 11 - Assembly



Technology Idea

Use this product for a mass production activity complete with appropriate jigs and fixtures.

Covering the Wing

1. Apply the tissue covering to the bottom of the wing. Cut the tissue slightly over size. Put a clear coat of fuel proof dope on the trailing edge. Press the tissue into place. When dry add a second coat of dope. It should soak through the tissue.
2. Pull the tissue tight over the leading edge. You may want to hold it in place with pins. Brush on a coat of clear dope. The dope will soak through the tissue and onto the wood leading edge. When dry, the dope will stick the tissue to the wood.
3. Using clear dope, stick the tissue to the center plate in the wing. Also stick the tissue to the end rib nearest the wing tip.



Integrated Activity Ideas

Examine the product sheets for any health and environmental concerns or precautions.

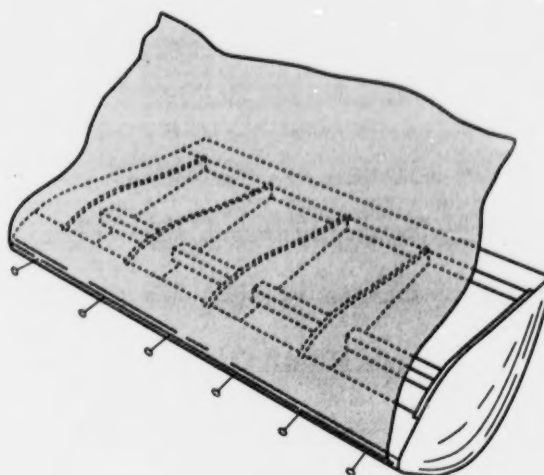


Figure 12 - Wing Covering

4. You have now fastened all four edges of the tissue to the wing. An alternate material which can be used is called Mono-Kote (available at model building and hobby shops. Mono-Kote adheres and shrinks to fit with the application of heat. It is available in both transparent and colored forms. Repeat this for the top and the bottom of both wings. Brush the tissue with water. When wet, the tissue will sag and look wrinkled. But, as it dries, it shrinks. This will make it tight and smooth on the wing.

Painting

1. Put a coat of fuel proof model airplane dope on the entire airplane. This first coat may be rough after it has dried. Some of the fibers of the wood will be raised and stiffened by the dope. Sand all WOOD parts. Do not sand the tissue covering.
2. Put on a second, and if needed, a third coat of dope. The airplane can now be decorated. Use different colors of dope or decals.

Engine

1. Attach the engine mount with bolts. Lock washers and two nuts in each bolt will be needed to keep the mount from vibrating loose when the engine is running.
2. The landing gear is held in place between the engine and the engine mount. Be sure the landing gear is in place. Lock washers and two nuts should be placed on each bolt. This will help prevent the engine from coming loose while the engine is running. If the bolts loosen from the engine vibration, a spot of glue on each bolt may help keep the nuts tight.



Flying

Lay out the control lines. Attach them to the leads coming through the wing tip of the airplane. A helper should hold the model. As you (the pilot) move the control handle, your helper should check to see that the controls are moving properly.

Fill the fuel tank. Attach the battery. Start the engine. Be sure the engine is running smoothly.

The pilot now runs to the control handle. The helper points the nose of the airplane slightly away from the pilot. This causes the airplane to pull slightly on the control lines when it first begins to fly. If the control lines should go slack, the pilot would lose control and the airplane would crash.



Integrated Activity Idea

Examine the aerodynamic principles used in flying airplanes related to the design of equipment and facilities for ski-jumping.

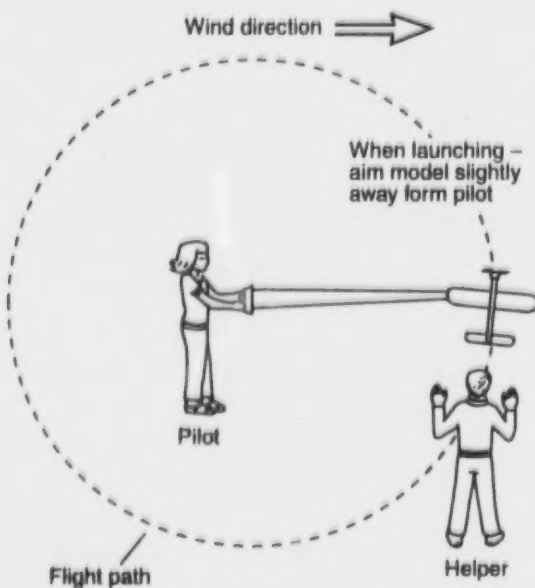


Figure 13 - Flight Test

When ready, the pilot signals the helper to release the airplane. At this point the pilot should have the controls in a neutral position. The airplane should rise off the ground quickly.

If this is the pilot's first time, just try to keep the airplane flying level. A slight up movement of the arm should make the airplane climb. Down movement of the arm will make the airplane dive. Very little movement of the controls will cause a great movement of the airplane. It is natural to overcontrol the airplane until some skill is developed in flying.

The control line must be kept taut at all times. If a gust of wind causes the airplane to move toward the center of the circle, the pilot will have to move backward a step or two to regain control.

Keep flying until the fuel supply has been used. The engine will stop. The airplane will glide smoothly down. To keep the lines taut, step backward. When the airplane nears the ground, the helper can retrieve the airplane. Be careful not to get the lines tangled. Careful, the engine will be hot.

When finished flying, wipe the oil from the engine and airplane. Drain any fuel from the tank. Remove the control lines and wind them carefully on the control handle. After the engine has cooled, it can be covered with a cloth to keep out dust and dirt.

Materials Needed

<i>plans, full size</i>	<i>tracing paper</i>
<i>scissors</i>	<i>model maker's knife</i>
<i>waxed paper</i>	<i>plywood, modelmakers 1/16" thick</i>
<i>music wire - landing gear</i>	<i>music wire - push rod</i>
<i>bell crank</i>	<i>control horn</i>
<i>cloth hinges for stabilizer control surfaces</i>	<i>fuel proof model cement</i>
<i>sheet aluminum for engine mount</i>	<i>paper covering/Mono-Kote for wing</i>
<i>fuel proof model airplane dope</i>	<i>straight pins</i>
<i>small Cox-type engine</i>	
<i>wheels bought or made from sheet rubber</i>	
<i>balsa sheet 1/16" thick</i>	
<i>balsa strip 1/4" square</i>	
<i>balsa strip 1' 2" square or preformed balsa leading edge stock</i>	
<i>balsa strip 1/4" x 3/4" or preformed balsa trailing edge stock</i>	
<i>balsa sheet 1/4" thick</i>	
<i>(Available at local hobby shop or kit may be purchased for U-controlled model airplanes.)</i>	

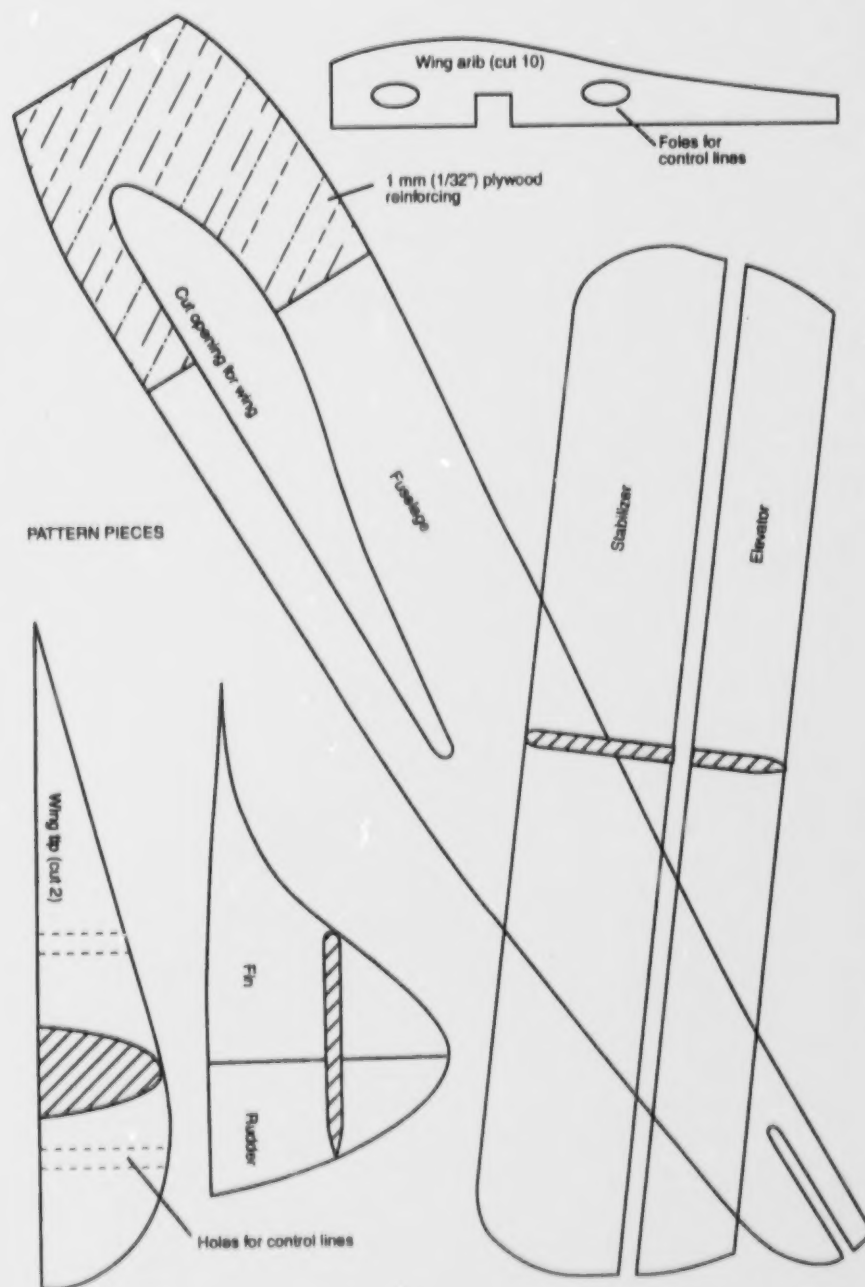
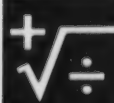


Figure 14 - Template

The template shown is 75% of its original size. You will need to enlarge it to 125% on your copy machine.

Activity 6



Integrated Activity Idea

Ask your physics instructor about centripetal force. How much force does the airplane exert on the line when it is moving at its top speed?

Hovercraft

Hovercrafts or air-cushioned vehicles (ACV) operate with a cushion of air flowing out from beneath the vehicle. The air which flows from beneath the craft must flow continually and be replaced with new air supplied by the lift system. The craft is also controlled by a propulsion control system which provides continuous air flow which can be directed and enables steering to take place.

In these activities we will be mostly concerned with the lift system only. However, if a student is so inclined they might also think up a control steering system for one or more of these hovercrafts.

Procedure

Paper Plate Hovercraft

Place cardboard tube on end in center of plate and trace around tube. Cut out hole in center of plate. Turn plate upside down on table and glue tube standing on end to the center of the plate using a hot glue gun. (See Fig. 15 below).

To operate, simply blow down through tube and craft will lift from the table. Steering is possible by blowing at an angle rather than straight down. Have students explain why and how lift and control system is made possible.



Integrated Activity Idea

How high can a plane fly before it needs oxygen for the passengers? Before it enters space, or can it? Why not?

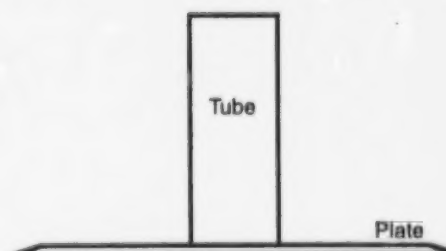


Figure 15 - Paper Plate Hovercraft

Balloon Hovercraft

Cut a circle 5"-6" in diameter from a manila folder. This size may be experimented with either smaller or larger to determine efficiency. Cut a hole large enough for balloon lips to fit through without pulling out easily in the center of the disc. Have students experiment with bending over the outer edges of the disc or slightly curving entire surface of disc downward to increase lift.



Testing the vehicle requires a ramp lifted 1-2' off the ground and a tape measure to measure distances. Have students blow up balloon and place craft at top of ramp (gravity provides the control steering system). Release the craft and record its distance traveled. Set a number for the students to record, such as 5 runs, and require the vehicle to have some change made before each run, so they can determine by experimentation what causes the best lift to occur.

Suggestions for experimentation: Cut discs different sizes, cut discs different shapes, increase or decrease size of hole in disc, bend edges, cut edges, fold edges, increase or decrease amount of air in balloon, etc.

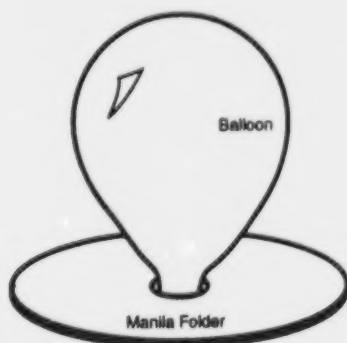


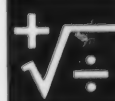
Figure 16 - Balloon Hovercraft

Meat Tray Hovercraft

Place propeller on motor shaft and determine spinning diameter size of propeller. Cut a hole in meat tray 1/8" larger than propeller spinning diameter in center of tray.

Cut sticks to various lengths (determined by student's design) and mount motor and prop above hole in tray. Prop should be slightly off table and spin clear of tray. Tray must be upside down for best performance, (curved side down) (The motor can be hot glued to wood and removed later without harm to motor using hot glue only - see Fig. 17.)

Attach wires, battery, and switch and turn on. It may take a little adjusting to balance out craft, due to weight of the battery. Craft will tend to try to spin, which can be helped by designing stabilizers, or designing a control steering system using another motor and prop placed vertically on the tray and supports. A ramp and experimentation may also be done with this hovercraft as was done in the balloon hovercraft, or designing a working control system could be done.



Integrated Activity Idea

Make a graph showing flight speeds from beginning to present time.



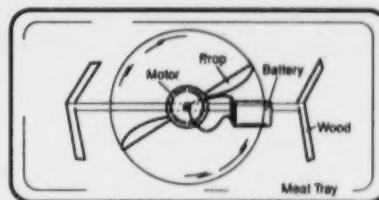
Technology Idea

Design and construct a hovercraft capable of hauling a full sized adult using a gas engine or an electric motor. (Refer to 1991 Implementation Workshop TAM by Dean Frame for ideas. Some Technology Education textbooks have this "full sized" activity included in their materials.)

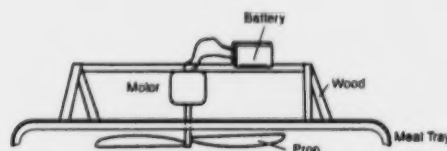


Technology Idea

Experiment with various sizes and shapes of trays. Predict what the results will be in advance.



Top View



Front View

Figure 17 - Meat Tray Hovercraft

Materials Needed

Paper Plate Hovercraft

paper plate
cardboard tube (toilet paper roll)
hot glue gun

Meat Tray Hovercraft

styrofoam meat tray any size
1/8 " square pieces of balsa (same as used for bridge building)
hot glue gun
9 v electric motor
switch (optional)
9 v battery
small plastic propeller
small amount of wire to wire battery to motor

Balloon hovercraft

manila folder
3"-6" dia. round balloon
sheet of plywood used for a ramp
25' tape measure



Assessment

Scoring Rubric for Activity 2 - Unpowered Gliders

Performance Standard	Wgt. %	Exemplary 2 pts	Acceptable 1 pt.	Not Yet Acceptable 0 pts.	Sub total
I. Creative Thinker					
Be able to gather, solve, understand, analyze, and apply information related to flight technology.	x1	Student successfully completes written assignments identified by teacher/text.	Student completes (at 70% successful rate) the written assignments identified by the teacher/text.	Student: completes (at less than a 70% successful rate) the written assignments identified by the teacher/text.	2 x 1 = 2
II. Critical Thinker					
Identify the basic motions of aircraft in flight.	x1	Student correctly identifies when the glider stalls, dives, or has preferred flight path.	Student identifies the basic motions of the glider with instructor's assistance.	Student does not identify the basic motions of the glider.	2 x 1 = 2
III. Contributing Citizen					
Assume roles related to positions in the aeronautic workforce (i.e., production worker, inventor, layout designer, foreman, etc.).	x.5	Student assumes and correctly portrays at least four roles of the aeronautic workforce.	Student assumes and correctly portrays at least two roles of the aeronautic workforce.	Student assumes and correctly portrays less than two roles or does not assume any role of the aeronautic workforce.	2 x .5 = 1
IV. Self-Directed Learner					
Use the scientific method to determine results of experimentation.	x.5	Student correctly implements the scientific method to determine results of experimentation.	Student correctly implements scientific of experimentation with assistance.	Student does not implement the scientific method of experimentation.	2 x .5 = 1
Locate and determine the center of balance for a glider.	x1	Student correctly locates and determines the center of balance for the glider.	Student correctly locates the center of balance for the glider with teacher's assistance.	Student does not correctly locate the center of balance for the glider.	2 x 1 = 2
V. Problem Solver					
Comprehend and solve simple and complex mathematical problems used in aeronautics.	x1	Student correctly calculates the trajectory of flight based on point of release and point of impact (showing all work).	Student correctly calculates the trajectory of flight based on point of release and point of impact with teacher assistance.	Student does not calculate the trajectory of flight.	2 x 1 = 2
VI. Effective Communicator					
Be able to effectively communicate the four forces acting on an aircraft.	x1	Student correctly and effectively communicates the 4 forces acting on the glider.	Student correctly and effectively communicates 2 of the 4 forces acting on the glider.	Student correctly and effectively communicates less than 2 of the four forces acting on the glider.	2 x 1 = 2
VII. Quality Producer					
Determine the most efficient aerodynamic shape of flight	x1	Student correctly determines most efficient shape of glider.	Student determines most efficient shape with assistance.	Student does not determine most efficient shape of glider.	2 x 1 = 2
Be able to manipulate and operate related technology to perform given tasks.	x2	Student correctly constructs glider to perform the required flight paths.	Student correctly constructs glider (with assistance) to perform the required flight paths.	Student does not correctly construct glider to perform the required flight paths.	2 x 2 = 4
VIII. Technical Foundations					
Be able to name and locate parts of a plane.	x.5	Student correctly names and locates all glider parts.	Student correctly names and locates 70% of all glider parts.	Student correctly names/locates less than 70% of all glider parts.	2 x .5 = 1
Know and be familiar with terms relating to aeronautics and aircraft.	x.5	Student knows all aeronautic terms identified by teacher/text.	Student knows 70% of the terms identified by teacher/text.	Student knows less than 70% of terms identified by teacher/text.	2 x .5 = 1

Total: 20 out of 20 Possible

Group Processes/Product Checklist for Activity 1

Yes	No	
		1. Students worked effectively as a group
		2. Math averaging done correctly
		3. Measuring done properly
		4. The planes followed the designs on the patent
		5. Contributed positively to discussion and analysis of results
		6. Followed the rules/parameters given
		7. Produced a quality sketch for patent
		8. Creative use of jigs, fixtures, and/or templates
		9. Produced a quality technical report

7-9 criteria met = Excellent

4-6 criteria met = Acceptable

0-3 criteria met = Improvement needed

Activity 2 Checklist

Yes	No	
		Able to name and locate parts of plane
		Names the four forces acting on a plane
		Able to follow directions to achieve a working plane
		Can explain difference between airfoil, dihedral, & polyhedral wings
		Knows how to balance a glider for performance
		Works safely and cleans up work area

TechFolio Checklist

Develop a flight tech-folio which could include:

Yes	No	
		Aircraft designs completed during the activities
		Ground school information
		Worksheets
		Historical paper (on flight)
		Tests
		Video from airshow



Activity 4 Checklist

Was student able to perform the following:

Yes	No
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐

Boot software

Take-off

Perform a roll

Perform and control yaw

Perform and control stall

Perform and control pitch

Make a safe landing

Control acceleration

Fly more than one type of plane

Completion Exercises

1. _____, _____, _____ and _____ are the four forces which act on an aircraft.
2. A dihedral wing would have tips that are slanted _____.
3. The body of an airplane is called the _____.
4. The four control surfaces of a plane are _____, _____, _____, and _____.
5. _____ refers to the movement of a plane turning left or right about the vertical axis.
6. _____ is the science relating to the effects of air or other gases in motion.
7. _____ m.p.h. is considered to be the speed of sound.
8. Mach is considered to be a speed of _____ m.p.h..
9. FAA is short for _____, which regulates the air transportation industry.
10. Name six parts of an airplane _____, _____, _____, _____, _____, _____.

Product and Personal Quality Assessment

Activity 5 - Line Powered Airplanes

- 4 = Excellent** (student successfully completes activity & displays mastery of subject/content/skill)
- 3 = Good** (student completes activity with good quality/knowledge of skill)
- 2 = Needs Improvement** (student completes activity without demonstrating mastery of subject matter or activity performance requirements)
- 1 = Not Acceptable** (student does not yet successfully complete the activity, needs additional work)

Product Quality

1. Quality of individual component fabrication (accuracy of dimensions, smoothness).	4	3	2	1
2. Joint and fit (quality of individual components fit up.)	4	3	2	1
3. Glue joint cleanup and finish.	4	3	2	1
4. Quality of moving part function lack of binding, excessive looseness, etc.	4	3	2	1
5. Waste minimized throughout project.	4	3	2	1
6. Jigs and fixture quality.	4	3	2	1
7. Overall finish and appearance of the plane.	4	3	2	1
8. Detail effects (decals, painting, logo, detail).	4	3	2	1
9. Function ability (flyability).	4	3	2	1

Personal Quality

1. Overall concern for craftsmanship.	4	3	2	1
2. Quality of design change/adaptation ideas.	4	3	2	1
3. Team work ability.	4	3	2	1
4. Safety consciousness.	4	3	2	1

Note: This assessment can be used as a peer, self or instructor tool.



Name _____

Affective Self and Peer Assessment

For each of the criteria, assign a rating to each member of the class or technology group (including yourself) on a scale of 4 - 0. (4 = excellent, 3 = good, 2 = average, 1 = poor, 0 = unsatisfactory.)

	Student A	Student B	Student C
Initiative (ability as a self-starter, self motivated)			
Use of time (consistently on task, productive, efficient)			
Reliability (regular attendance, carry tasks through to completion)			
Work quality (tasks and operations were well done,			
Idea quality (good problem solving skills and ideas)			
Ability to work with others (ability to share tasks, contributing team member)			
Overall knowledge of flight			
TOTALS			



By John Petsch

Instructor Resource

Lighter Than Air

Content Outline

1. History of Flight

- Basic Design Attempts
- Powered Flight
 - ◆ Propeller propelled
 - ◆ Jet propelled
 - ◆ Fuel Systems

2. Flight Principles

- Aerodynamic Principles
 - ◆ Physics of flight
- Control Systems
- Wing Design
 - ◆ Shape
 - ◆ Angles
- Fuselage Shape

3. Materials & Processes Used In:

- Aircraft Construction
- Composites
- Expandable "fill" for cavities

4. Communications & Flight

- Radar
- Radio Control
- Automated Flight
- Doppler

5. Future Possibilities

Instructional Resources

Books

Bame, E. A., Cummings, P. (1980) Exploring Technology Activity Act Manual. Davis Pub. (Activity pg. 111-121).

McCrary, T. Understanding and Using Technology. (1986) Davis Pub. (pp. 153-158).

Ninomiya, Y. White Wings. (1990) AG Industries.

Secrets of Model Airplane Building, Philadelphia, PA. Sterling Models, Inc.

Supplies

Sporty's of OHIO 1-800-LIFTOFF

Glossary of Terms

Aerodynamics - the science relating to the effects of air or other gases in motion.

Aileron - a moveable control surface attached to the trailing edge of wing to control an airplane roll.

Airfoil - a surface or body such as a wing or propeller, designed to obtain a reaction, as lift or thrust, from air.

Altimeter - the indicator that gives information on the aircraft's present altitude. It is usually calibrated to give mean sea level (MSL) altitude. Most altimeters are called pressure altimeters because they measure the decrease in pressure as the aircraft climbs. Because of this, the altimeter must be calibrated to the local atmospheric pressure to compensate for local variations in the pressure that would make the readings inaccurate.

Angle of Attack - the angle between the wing's chord line and the relative wind.

Chord - the measurement of the wing taken from the leading edge to the trailing edge.

Cockpit - area of plane in which the pilot and instrumentation is located.

Dihedral - a wing set at an upward angle from its center point.

Drag - the retarding force acting upon a body in motion; wind resistance.



Elevator - a horizontal, hinged control surface, attached to the trailing edge of a horizontal stabilizer of an airplane, designed to control the airplane about the lateral axis.

FAA - Federal Aviation Administration - an association which regulates and controls the air transportation industry.

Flaps - movable airfoil sections, located on the trailing edge of the wings, that are lowered on takeoff and landing to increase the wings' lift and drag.

Flare - leveling off a foot or two above the runway prior to landing by raising the nose of the aircraft just prior to touchdown. This is the last segment of a landing approach.

Fuselage - the main body of the airplane.

Ground speed - the aircraft's actual speed relative to the ground. For example, if an aircraft is flying level at 120 knots true airspeed and has a 15-knot headwind, its ground speed is 105 knots.

Heading - the direction in which the aircraft is pointed. This is not necessarily the direction the plane is traveling. It is usually referred to as a magnetic heading, but "degrees" typically is omitted by experienced pilots ("My heading is 324").

Hypersonic - moving five times faster than the speed of sound.

Knot - a rate of speed equal to 1 nmk/h (6076.1033 ft/h) or <1852 m/h>.

Lateral axis - imaginary axis running from side to side through the wings.

Lift - an upward pressure equal to or greater than the weight of the air displaced by the object.

Longitudinal axis - imaginary axis running from front to rear through an aircraft's center of gravity and approximately parallel to the thrust line (the propeller's axis).

Mach - unit for airspeed equal to 760 mph, speed of sound.

Pitch - movement of an airplane diving or climbing.

Pneum chamber - area of the hovercraft that contains the pressurized air.

Propeller - a series of blades attached to a shaft, that when rotated, produce thrust causing the plane to move forward.

Roll - movement of an airplane twisting without any change in direction.

Rudder - a vertical control surface hinged to the tail post aft of the vertical stabilizer, designed to apply yawing motions to the airplane.

Skid - an aircraft's sideways sliding away from the center of the curve while in a turn.

Slip - an aircraft's sideways motion while turning.

Supersonic - speeds above the speed of sound.

Thrust - a reaction force measured in pounds.

Vertical stabilizer - the surface of the aircraft that is used to help control motion about the aircraft's vertical or yaw axis.

Yaw - the movement of an aircraft about the vertical axis; turning left or right.

Safety Factors

- Keep eyes covered and protected when flying planes, even paper planes.
- Ventilate room thoroughly when using airplane dope, take short breaks frequently to move from vapors or use respirator.
- Handle hot engines carefully. Do not start until all are clear of propeller.
- Be sure fan used for wind tunnel has adequate guards.
- Keep fingers from propeller in meat tray hovercraft when turning.
- Protect eyes when inflating balloons for balloon hovercraft as bursting may cause pieces to fly into the eyes.
- Follow manufacturer's warnings when handling airplane fuel.

Instructional Suggestions

Motivation

- Arrange for a field trip to a control tower, or video tape and show to classes.
- Show a small portion of a fighter scene from a movie such as "Top Gun" and have students describe how the movements are accomplished.
- Enter students' work into local or state competitions where applicable and available, or start one in your community.
- Obtain a copy of air traffic controller's exam and let your students give it a try. (Must be made available due to the truth/information act.)
- Develop and arrange a mini-career fair for aeronautical careers.
- Build, buy, borrow, or invite someone to fly a remote controlled airplane on the school grounds and have students record the maneuvers. Take results and have students describe wing flap positions needed for each maneuver.

Prerequisite Information

- Previous experience building paper airplanes or viewing of paper airplane books (Activity 1).
- Lesson on airfoils and aerodynamic shapes (Activity 5).
- Prior computer use, booting, mouse usage, etc. (Activity 4).
- Basic problem solving skills and methodology.

Demonstrations

- Basic sketching techniques.
- How to use any power tools needed for building, cutting, etc.
- Methods for launching all vehicles built.
- Basic wiring needed for a battery hookup.
- Demonstrate all safety procedures for your welfare and that of your students.



Academic Enrichment

- Develop an activity into a science project for a fair, i.e., Activity 1 - design vs. distance or design vs. loft time.
- Write a report on the history of aircraft and predict the future.
- Team teach with science teacher to cover flight principles, aerodynamics, forces, etc.
- Pull formulas from "White Wings" guide and have the math teacher teach skills needed to solve problems on student built aircraft.
- Have students interact with the computer teacher to see if they could draw and develop on computer various plane parts for future building.

Related TAMS

- Introduction to Energy and Power Guide
TAM 7 Adventures in Flight
- 1990 Implementation Workshop TAMS
TAM 4 Hot Air Balloons
- 1991 Implementation Workshop TAMS
TAM 1 Flight Technology and Aerodynamics
TAM 9 Vacuum Cleaner-Powered Hovercraft

Assessment/Evaluation Suggestions

- Insist on neatness and accuracy when recording flight results and during experimentation activities.
- Consider including safety into overall grade.
- Use checklists when doing activities the first time, and then you can be more specific next time, once you get a feel for student abilities at your grade level.
- Include cooperative interaction between students working in groups as part of grading.
- Create opportunities for self-assessment and time for self-correction whenever possible.

Notes: Review the assessment items which are presented throughout the Performance Standards TAMS for ideas which can be adapted for this TAM. You should also refer to the Performance Standards Implementation Handbook for additional assessment examples and ideas.

Answers for Completion Exercise

1. Lift, thrust, drag, gravity
2. Upward
3. Fuselage
4. Flaps, ailerons, rudder, elevators
5. Yaw
6. Aerodynamics
7. 725
8. 1,760
9. Federal Aviation Administration
10. Propeller, engine cowl, wing, fuselage, stabilizer, rudder, elevator, landing gear, aileron, flap
*horizontal or vertical.

Summary

Air travel has come a very long way in a relatively short time. New improvements in flight come out at an ever increasing rate with higher and higher degrees of technology. Fighter planes are now flown and guided by computers attached to the pilot's helmet. This enables the pilot to fly by simulation on his face shield, and he or she may never see the actual sky or ground while in the air.

While costs and technology have gone up, it is still possible to become a pilot with little or no money. One can build his own plane, buy a hang-glider, or build or buy an ultralight plane. Many avenues are open to anyone with the yearning to fly, and just as many careers in aviation are also available. The decision to just simply enjoy the thrill of flight or to make a career of it is simply a matter of desire and training.



The Final Frontier

Goal

This TAM is designed to provide a basic introduction to and hands on experience with activities about space, space travel, the international student space simulation, and the National Aeronautics Space Administration (NASA) program.



Mathematics



Communications



Science



Social Studies



Fine Arts



Health



Technology

Performance Standards

- Project future technologies which could be expected to emerge from space exploration and travel.
- List and describe the various applications of space technology, including everyday, specialized, and future uses.
- Recognize and analyze the potential positive and negative impacts of space exploration, development and travel on society.
- Practice all safety procedures when interacting with space-related equipment and procedures.
- Identify typical industrial, educational and societal sectors that may benefit most from the products, knowledge, and designs of the space industry.
- Develop a design for and solve problems related to constructing a simple, deployable space station simulation.
- Communicate orally, visually, and/or in writing the principles of actual and potential space travel.
- Define and discuss terminology which is unique to the aerospace industry.
- Construct a model space station simulation.
- Identify the various foundation skills and possible career options in the aerospace industry.
- Define those practices and terms used in space programs, including NASA, satellites, space stations, skyways, and space structures.



Introduction

Outer space is truly the final frontier. It starts approximately 110 miles above the earth's surface where the atmosphere is so thin that it no longer effects objects moving through it. Outer space goes in every direction and has no known limits. Within space are billions of galaxies made up of billions of stars. Our solar system is truly a minuscule speck compared to the grand scheme of outer space.

Probably since the beginning of time people have dreamed of flying to the stars. Space travel is one of humanity's greatest adventures. Our modern space program began in earnest when the United Soviet Socialist Republic (USSR) launched a small beeping metal ball, Sputnik, into an earth orbit on October 4, 1957. This single event sent shock waves through this country's scientific and engineering communities. A major new push toward more science in the school was one result. The space race was on!

The first manned space flight happened April 12, 1961 when Soviet Cosmonaut, Yuri A. Gagarin circled the earth in his spaceship. One month later Allen B. Shepard flew 15 minutes in space for the American space program. But, it was not until February 20, 1962 that John Glenn Jr. actually orbited the earth for the United States. Neil A. Armstrong and Edwin E. Aldrin, Jr. were the first human beings to set foot on the moon July 20, 1969. The latest stage in space exploration began on April 12, 1981 when John Young and Robert Crippen flew the first reusable space shuttle.

Objective Statement

The activities described in the following pages represent samples of activities which can be used to deliver the performance standards on page 1. Many additional activities can and should be used. Extreme care should be taken to connect each activity with appropriate activity objectives as well as with the above performance standards. These objectives should be developed by the instructor and should be shared with and made clear to the students.

Activity 1



Technology Idea

Explore career options in space related areas. You can do this by taking a vocational interest inventory, visiting with those involved in space related careers, exploring information available of Spacelink, exploring the Dictionary of Occupational Titles (D.O.T.), etc.

Propulsion

Most of us have watched a Space Shuttle launch on Television. Have you ever wondered what the shuttle was doing to get off the launch pad and into outer space? To be able to understand the physics of rocket propulsion you need to understand Sir Isaac Newton's Third Law of Motion. Newton's Third Law of Motion-For every action there is an equal and opposite reaction.

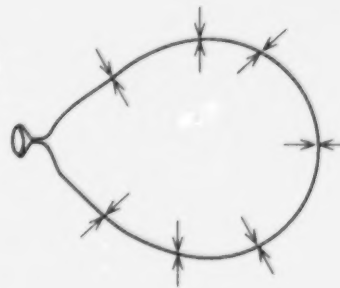


Figure 1 - Newton's Law

If you blow up a balloon and hold it closed, the pressure inside is balanced by the atmospheric pressure outside.

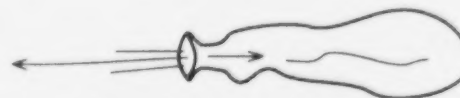


Figure 2 - Pressure Released

But, if you let go of the balloon the outside pressure, plus the tension of the balloons surface force the air out of the balloon's nozzle. This is where Newton's Law comes in. The action of the air leaving in one direction causes an equal reaction and the balloon begins to fly forward.

When a rocket engine is burning, it produces gases, smoke, and fire that have no place to go but out through the nozzle. The gases rushing out of the nozzle cause an equal reaction which pushes the rocket forward.



Integrated Activity Idea

Do a historical study of Newton's development of the law of motion? What were the factors that led to the "discovery?" Would you say that it was the result of systematic inquiry or was it accidental? How has its application changed our lives?

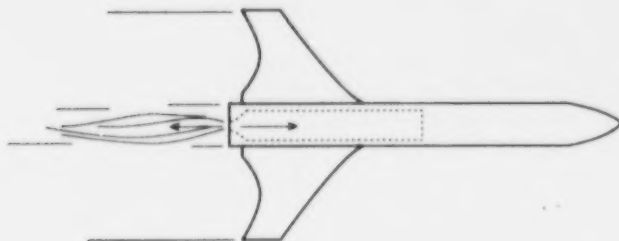


Figure 3 - Rocket Propulsion

There are certain key concepts that you must understand to be able to design a rocket that will fly correctly. The next few paragraphs talk about levers, teeter totters, and arrows. This is so you can understand the key concepts and then apply them to your rocket design. Please read carefully and bear with us. Hopefully it will all make sense in the end.

If you took a board and balanced it on a pivot point (fulcrum) you would have a first class lever or teeter totter.

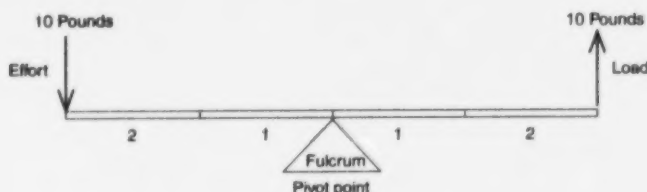


Figure 4 - Balanced Board

Since the board is balanced, 10 pounds of force (effort) at one end, it would lift 10 pounds of weight (load) at the other end.

The point which the two sides of the board are balanced is called the **Center of Gravity** or **CG**. If you increased the force (effort) to 30 pounds on the balance you could move the pivot point (fulcrum) one whole unit toward the effort end and still lift the 10 pound load.

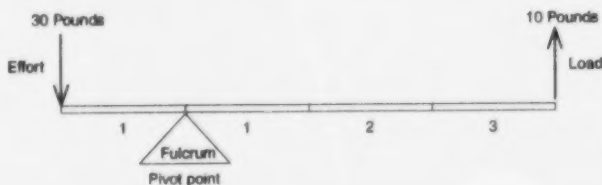


Figure 5 - Fulcrum Shift



Technology Idea

Draw a picture of the three classes of levers and provide an example of each one. You could go further by making a Rube Goldberg device which includes configurations of all classes.



Technology Idea

One of the important areas of study in Technology Education has to do with the impacts of technology on society. Often these impacts go unnoticed and unappreciated. Sometimes they're harmful and sometimes helpful. How would you say that rocketry has changed our lives? Start with the first rockets back in early history.

This is due to something called mechanical advantage. Since the effort is 3 times greater than the load the effort side of the lever must be 3 times shorter. It is interesting to note that the number on one side of the fulcrum equals the numbers on the other side. They are in balance.

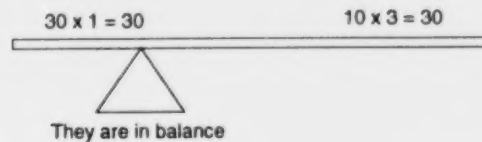


Figure 6 - Balance

If you took an arrow shaft without feathers or point, found its CG, and then shot it into the air it would tumble to the ground.



Figure 7 - Arrow without Feathers

Knowing your CG alone will not help your arrow or rocket fly. It is the feathers that keep an arrow going straight and true. When an arrow with feathers is shot, if the tail starts to rise the air passing the arrow begins to push against the feathers and push the arrow tail back in-line with the point.

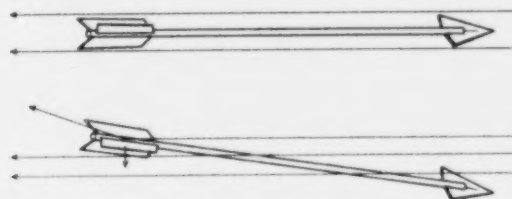


Figure 8 - Arrow with Feathers

If the tail is forced down too fast it will go below the point. Now the wind is pushing on the other side of the feathers and pushing the tail back up into alignment with the point.



Figure 9 - Arrow Realignment



Technology Idea

Have students develop a launch sequence that assures the safety of people, places, and things from wild or misfired rockets.



There is a point on the arrow's shaft which the feathers rotate around. This is called **Center of the Pressure** or **CP**.

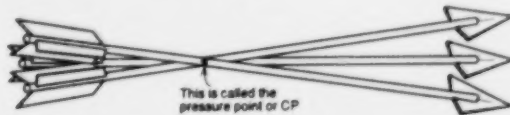


Figure 10 - Pressure Point

As you can imagine, the more the arrow wobbles out of alignment, the more the air pressure pushes on the feathers.

As long as the feathers keep the CP slightly behind the CG on the arrow shaft the arrow flies straight. However, if the CP is ahead of the CG the feathers are unable to correct the flight fast enough and the arrow will wobble out of control. It may even switch ends and fly backwards!

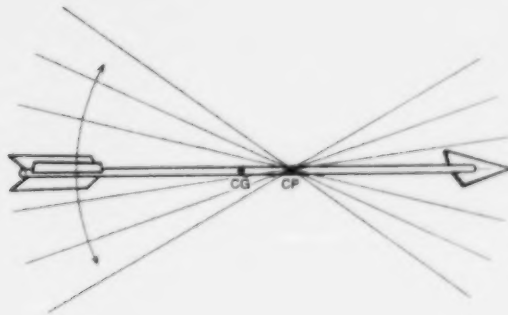


Figure 11 - Misaligned Center of Gravity

All of this applies to rocket flight too! The key to accurate rocket flight is to have fins large enough to apply enough effort to keep the CP behind the rocket's CG, but not adding so much weight and drag to the rocket that its speed and altitude (range) are greatly diminished.

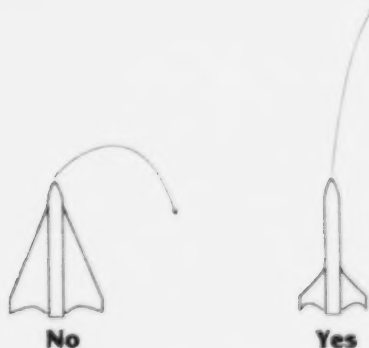
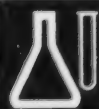


Figure 12 - Rockets



Integrated Activity Idea

Explain how lift and drag affect your rocket's performance. Develop an explanation of this from the point of view of physics. Prepare an illustrated technical report which describes the process. Where do these same principles apply (automobile aerodynamics, large bridge and superstructure design, etc.)



Technology Idea

Problem solve an idea for another way you could test the flyability of your rocket if you couldn't use the string test. Remember that one of the most important qualities of innovators, inventors, and designers is their ability to find a variety of solutions for thorny problems.



Technology Idea

Analyze some other transportation devices to determine how center of gravity concerns have been designed in. Examples include automobiles, snowmobiles, jet skis, large trucks, cranes, forklifts, etc. What factors are common to all of these devices?

The way to test your rocket for stable flight is to string test it. Be sure the rocket is fully loaded and ready to fly (engine, etc.).

1. Find its center of gravity by balancing it on a straight edge until it balances.
2. Mark the CG line on the rocket tube.
3. Now make a mark, on the diameter of the rocket tube ($3/4"$), below the CG line and mark it CP.
4. Tie a 6 foot string exactly on the CP line and tape it so it won't slip.
5. Now, away from students, windows, cars, etc., slowly start to spin the rocket around your head.

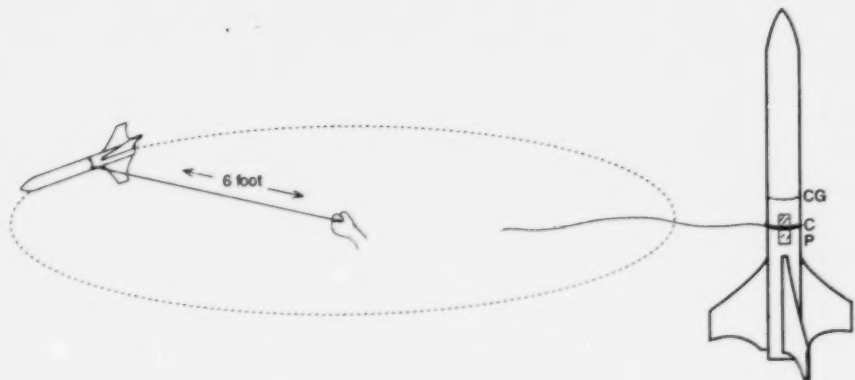


Figure 13 - Test Flight

6. If the rocket flies nose first without wobbling, you are ready to launch your rocket.
7. If it wobbles excessively or flies backwards, your CG is in front of your CP, and you need to modify your rocket for better stability.

Possible options

- Increase fin area.
- Change length of rocket tube.
- Change weight distribution-CG.

Procedure

1. Apply the concepts you have learned to design your rocket. Draw on the graph paper in pencil and draw the rocket full scale. Be sure to make detail drawing of your nose cone and fins.



2. Have your teacher check your drawings. If everything is correct, recopy over the pencil in ink.
3. Get a 3/4" dowel rod to use as a body form.
4. Using white mimeograph paper, roll it around the dowel and tape the edge with scotch tape. Be sure not to tape the paper to the dowel.

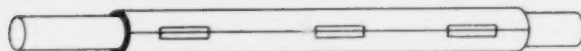


Figure 14 - Paper on Dowel

5. Using 1" inch brown box tape, wet it and apply one spiral layer over the white paper. Be careful to slightly overlap each layer with the next. It's best to practice with tape first, before you do it wet.



Figure 15 - Spiral Layer

6. Allow it to completely dry.
7. Apply a second layer of tape that diagonals the opposite direction.

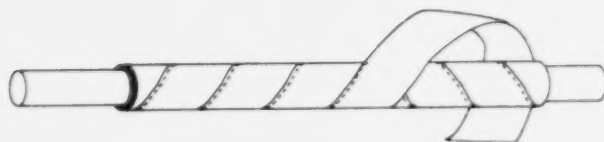


Figure 16 - Second Spiral Layer

8. Allow it to dry.
9. While tube is still on dowel trim each end square and to the correct length. You can use an X-acto knife, utility knife, or make a rocket chopper.
10. Gently remove dowel from inside the tube. Sometimes gently twisting in the opposite direction you wound on the memo paper will help.
11. Get a nose cone blank-Insert it into rocket tube and check for slightly snug, but not tight fit.
12. With the nose cone blank in the tube, cut and sand nose cone to the desired shape.
13. Layout fin design on matt board to make a repeatable pattern.



Integrated Activity Idea

Locate some old comic books and science fiction books that your parents may have kept since they were kids. Many of these were very interested in space travel. Compare the designs and ideas presented and illustrated in those materials with what has actually been developed today. Do they have the same general features and "look?" How much do you think our current concepts of how space vehicles should look have been scientifically developed and how much has it depended on common notions of what these should look like? Do rockets look like they do because their designers read science fiction as kids? What do you think?



Integrated Activity Idea

Explain what constitutes an aerodynamically "slick" contour. Illustrate some contours which are good and those which do not work well. Test in a wind tunnel, then explain the results based on the results of physics principles.

14. Cut fins out of stock and fine sand them to aerodynamic profile.



Figure 17 - Fins

15. Put engine clip onto tube. Do not poke holes, carefully drill them. Use a LARGE paper clip and bend as shown.

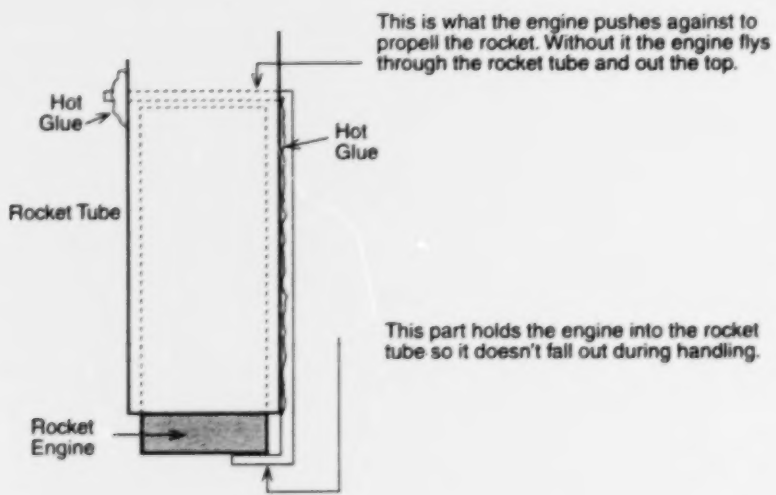


Figure 18 - Engine Clip-on Tube

16. Put eye screw into nose cone and dip the whole assembly into epoxy. Hang by the eye screw to dry. Be sure epoxy coats the eye screw threads too. This will hold it securely to the nose cone.



Figure 19 - Nose Cone



17. Glue launch lug close to the bottom with hot melt glue. Be sure that it is pointing on axis with the rocket tube.

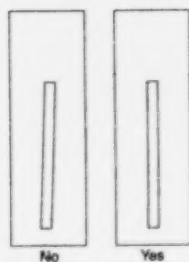


Figure 20 - Fins to Body

18. Carefully hot melt fins to body. Be sure they are exactly evenly spaced and in perfect alignment.

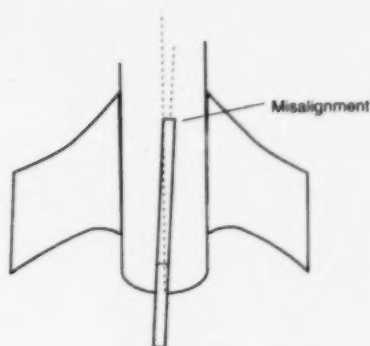


Figure 21 - Check for Misalignment

19. Lay out the parachute onto plastic. Tape string to the chute and tie together.

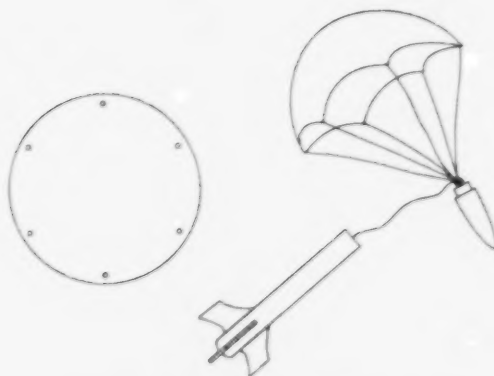


Figure 22 - Parachute Layout



Technology Idea

Develop a sanding jig that will allow you to sand the nose cone of your rocket only to the shape you want but symmetrical as well. Additionally, design and make a fin gluing jig for 3, 4, and 5 fin rockets.

20. Hook chute to nose cone and tether string from nose cone through hole at top of rocket body.
21. Load your engine.
22. Fold and pack your chute.
23. Pack, tether, and insert straight nose cone.
24. Using a thin sharp straight edge find your rockets center of gravity-CG and draw a line around the rocket tube.



Technology Idea

Have a contest for flying the highest, most accurate (hit the "x"), the longest flight time, etc.

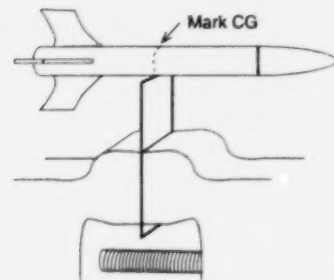


Figure 23 - Determining Point of Balance

25. Measure below the CG, the diameter of the rocket body ($3/4"$) and draw a line for the desired center of pressure (CP).
26. Tie a 6 foot piece of string exactly around your CP line and tape it in place.



Figure 24 - Attach String

27. String test your rocket.
28. If rocket flies correctly, remove engine, nose cone, and chute, and paint rocket and nose cone.
29. When dry, reassemble, **ONLY THIS TIME BE SURE TO ADD WADDING BEFORE LOADING YOUR CHUTE.**

The wadding can be paper towel, tissue or fiberglass insulation. It keeps your chute from being melted when the ejection charge goes off. It



should fit snugly enough to seal the tube, but loosely enough to be able to move up the tube and kick out the nose cone.

The wadding goes in before the parachute and should go down far enough to allow the chute to easily fit inside too.

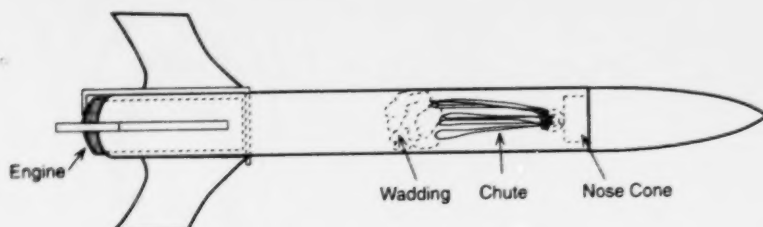


Figure 25 - Packed & Ready to Go!

30. You are ready to fly!

Materials Needed

graph paper
bags
scotch tape
1" brown packing tape/wettable
hot melt glue & gum
6 v battery (lantern)
eye screws
polly brushes to apply epoxy
x-acto knives
wadding
paper clips (large)
matt Board for fins, templates, etc. - free from frame shop

ESTES

Rocket Launcher
Engines "B" size each 6B-4
Ignitors

plastic for chutes - baggies, trash
3/4" dowel rods - 16" long
string
30' 18 ga. zip cord/launch wire
blue foam or balsa for nose cones
epoxy (2 part)
paint
steel rules (balance edges)



Technology Idea

Explain the reasons for the graphics you will put on your rocket such as visibility, warnings, identification, etc. How do these reasons match with those which are placed on real rockets?



Integrated Activity Idea

Explain the role rocketry has played in the development of global communications. Illustrate with specific examples.

Activity 2

NASA Spacelink

NASA is without a doubt one of the most supportive institutions of education there is. It has a wonderful educational data base that is available to the public called "Spacelink". All you need to access NASA Spacelink is a computer, a modem of 300 baud or more, communications software (which you can get for free from shareware) and an outside phone line. You can call long distance to Huntsville, AL. But the best way would be to use MORETECH, TELNET or INTERNET and talk for free. See TAM 3 - Telecommunications by Lynn Diel for more information. (Another great resource person is Flint Wild, a former Technology Education teacher from Kansas City, Kansas, who was employed by NASA to operate and manage Spacelink. He can be contacted through Spacelink.)



Integrated Activity Idea

Explain why it is necessary for all citizens to become comfortable cruising around on the Infobahn. Use your imagination to dream up what kinds of telecommunications devices and possibilities you can imagine being developed in the future. Select 3 of the most likely to happen and prepare a report on the implications of these developments for individuals and society as a whole.

I have my students go through a tutorial that teaches them how to use the modem and log on the Spacelink. After that they become "info surfers" on the "infobond" they are required to find out specific bits of information that I have requested, from the Spacelink system. After that the students are usually hooked and I have to force them to shut down at the end of the class. You will find that they will use the Spacelink excessively when working on any aerospace activity if it is available to them.

NASA Spacelink runs on a Data General Eclipse MV-7800 minicomputer at the NASA George C. Marshall Space Flight Center in Huntsville, Alabama. The Spacelink software was developed and donated to NASA by the Data General Corporation. The system has a memory of 14 megabytes and disk storage space for 2 gigabytes. It runs at 300, 1200, 2400, or 9600 baud. Data word format is 8 data bits, no parity, and 1 stop bit. The system was made public in Feb., 1988.

While NASA understands that people from a wide variety of backgrounds will use NASA Spacelink, the system is specifically designed for teachers. Unlike bulletin board systems, NASA Spacelink does not provide for interaction between callers. However, it allows teachers and other callers to leave questions and comments for NASA.

Procedure

You can connect to NASA Spacelink directly by dialing (205) 895-0028. However, be forewarned. It is a long distance call and it's easy to spend lots of time on the system once you get on and find out what all is in there.

1. By far the best way to access Spacelink is to go through MORETECH. To do this logon onto your MORETECH account.
2. Next, select #7 - Internet Resources from the main MORETECH menu.
3. Select #10 - Telnet Sources to get you into the Telnet protocol.



4. Next select **#2 - Open Telnet**. At the prompt (—> 1. Enter a specific telnet site <?>) enter the following address: **spacelink.msfc.nasa.gov**. Note that the period after gov must be there for the system to work. The first screen which comes up will welcome you to the NASA SPACELINK. Congratulations! You've arrived at the NASA's front door.



Integrated Activity Idea

Entertain and discuss the question "Why is NASA Spacelink free and open to the public? How does this reflect the values of our culture? Cite examples of how these kinds of policies would not be possible in other countries.

Figure 26 - Opening Welcome Screen

5. Now you must get logged on. The first time through, it's a little more involved but not too much. The first time on, enter NEWUSER at the prompt which asks you for a userid. Use NEWUSER also at the prompt requesting a password.
6. After you have issued these, the system will walk you through a series of questions (name, address, phone, etc.). You will also be prompted to issue a new userid and password. The next time you log on you will use your new userid and password and will not need to go through all of the initial sign up information.
7. The next menu which appears is your main menu. This is a key menu because it is your gateway into the entire system. It looks like this.

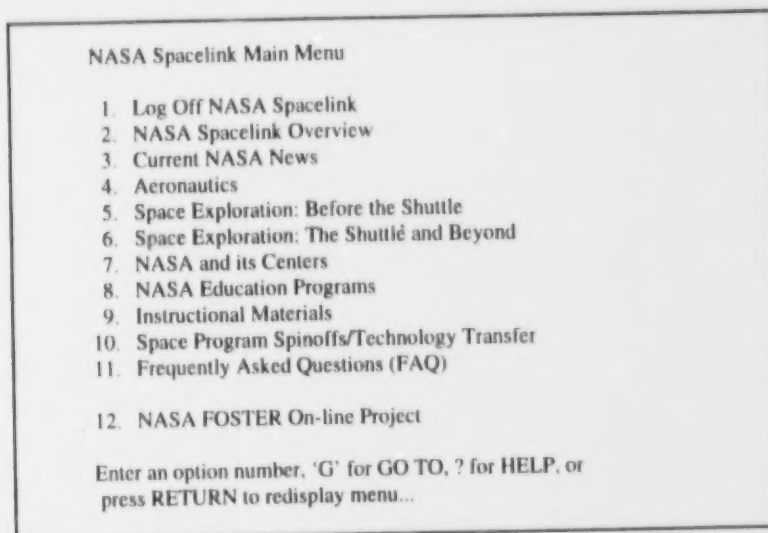


Figure 27 - Main Menu

8. The remainder of this activity will consist of presenting you with an overview of the kinds of resources which are available in Spacelink. Space simply does not allow a complete presentation of all of these resources because, as you'll soon see, there are so many. In the steps which follow you will be introduced to the contents of each of the subscreens which appear on the main menu. You will then want to "dig into these" for the "good stuff." You'll be amazed at all of the resources that are out there on the system. Each of these menus will be presented in order beginning with #2 (since #1 is the one you use to log off of the system). So here goes!

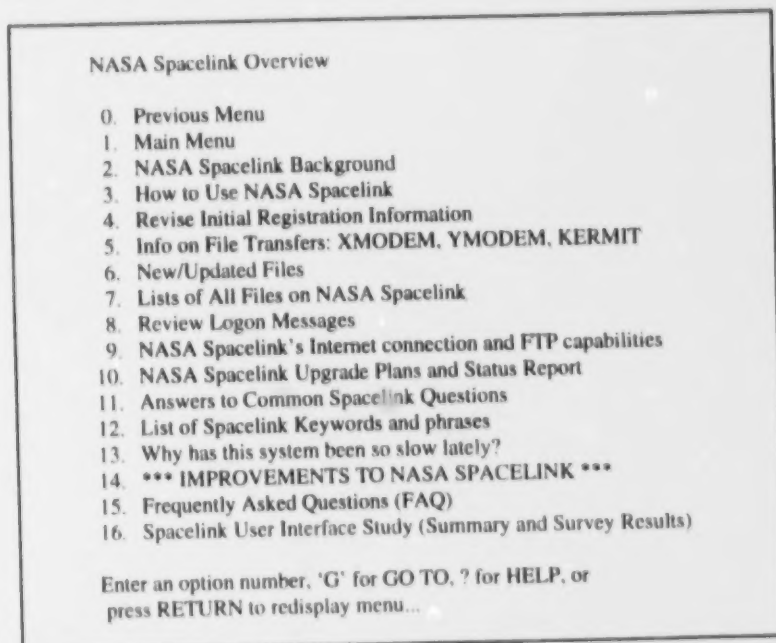


Figure 28 - NASA Spacelink Overview



Current NASA News

- 0. Previous Menu
- 1. Main Menu
- 2. NASA Educational Programs
- 3. NASA News Releases
- 4. Shuttle Status Reports
- 5. NASA Congressional Testimony and Speeches
- 6. Launch Dates and Payloads
- 7. Year in Review/NASA Year-End Reports
- 8. Daily News/NASA Television Schedule
- 9. Newsletters for Educators
- 10. Magellan Status Reports
- 11. Galileo Status Reports
- 12. Ulysses Status Reports
- 13. Recent Shuttle Mission STS-61 (Hubble Space Telescope Servicing Mission)
- 14. Hubble Space Telescope Status Reports
- 15. NOT AVAILABLE
- 16. Monthly NASA Television Schedule
- 17. Recent Shuttle Flight STS-59

Enter an option number, 'G' for GO TO, ? for HELP, or press RETURN to redisplay menu...



**Integrated
Activity Idea**

Do a study of a current event discussion in NASA News. Report back to the whole class. Attempt to find news which is both interesting and informative.

Figure 29 - Current NASA News

NASA Aeronautics

- 0. Previous Menu
- 1. Main Menu
- 2. Basic Research and Technology
- 3. High Performance Aircraft and Research
- 4. Subsonic Aircraft and Transportation
- 5. New Aviation Applications
- 6. NACA 75th Anniversary
- 7. Ames-Dryden Flight Research Facility
- 8. The National Advisory Committee on Aeronautics

Enter an option number, 'G' for GO TO, ? for HELP, or press RETURN to redisplay menu...

Figure 30 - Aeronautics

Space Exploration: Before the Shuttle

- 0. Previous Menu
- 1. Main Menu
- 2. A Brief History of Rocketry
- 3. Mercury
- 4. Gemini
- 5. Apollo Lunar Program
- 6. Skylab
- 7. Apollo Soyuz Test Project
- 8. Astronauts
- 9. Early Launch Vehicles
- 10. Satellites
- 11. Space Observatories
- 12. Planetary Probes

Enter an option number, 'G' for GO TO, ? for HELP, or press RETURN to redisplay menu...

Figure 31 - Space Exploration: Before the Shuttle



Integrated Activity Idea

Discuss your ideas and feelings about NASA's future plans for space travel and life. Do you think the space station is a good idea? Why? What specific contributions will it make to society? How should the concerns for individual astronauts (safety, quality of life on long term voyages, isolation, etc.) be weighed compared to the potential advantages to society? Which should be most important? Do the ends justify the means?

Space Exploration: The Shuttle and Beyond

- 0. Previous Menu
- 1. Main Menu
- 2. The Space Shuttle
- 3. Astronauts
- 4. Current NASA Launch Vehicles
- 5. Future Launch Vehicles and Propulsion Systems
- 6. Earth Observation and Communication Satellites
- 7. Space Observatories (Hubble space telescope and Others)
- 8. Planetary Probes
- 9. Spacelab & Other Space Science Missions
- 10. Space Station
- 11. Future plans
- 12. U.S./russian Coopreation in Space
- 13. NASA Computers
- 14. High Resolution Microwave Survey-HRMS (Radio signal search)
- 15. Earth Observation Reports
- 16. Orbital Debris Study
- 17. Ground-Based Astronomy and Space Science

Enter an option number, 'G' for GO TO, ? for HELP, or press RETURN to redisplay menu...

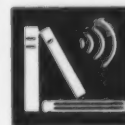
Figure 32 - Space Exploration: The Shuttle and Beyond



NASA and its Centers

0. Previous Menu
1. Return to Main Menu
2. The NASA Centers
3. The Aeronautics and Space Act of 1958
4. Orders of Magnitude: A History of NACA and NASA, 1915-1990
5. NASA Objectives
6. Biography of NASA Administrator Daniel Goldin
7. NASA Budget Request FY 1995
8. Principal Recommendations Section of Augustine Commission Report
9. NASA Art Program
10. Frequently Asked Questions (FAQ) About Aeronautics and Space
11. NASA and UFO's
12. NASA Vision Team Memorandum to NASA Employees (6/5/92)
13. Offering Ideas to NASA
14. The Years in Review (Year-end Reports)
15. 1992 NASA Town Meetings
16. NASA Television and Audio Services

Enter an option number, 'G' for GO TO, ? for HELP, or press RETURN to redisplay menu...



**Integrated
Activity Idea**

Select a number from 2-16 on the menu and develop a report of the information to the class.

Figure 33 - NASA and its Centers

NASA Educational Services

0. Previous Menu
 1. Return to Main Menu
 2. NASA Education Program Introduction
 3. NASA Elementary and Secondary Programs Applications (OSSA)
 4. NASA Higher Education Programs
 5. NASA Technology and Evaluation Programs
 6. NASA Educational Publications
 7. NASA Aerospace Educational Resources
 8. *** (Menu items 2-7 in One Document) ***
 9. NASA Mobile Teacher Resource Center
 10. Lunar Sample Education Project
 11. Space Science Student Involvement Program (SSIP)
 12. NASA Educator Mailing List
 13. University Guide to NASA (1993)
 14. NPSO Graduate Fellowships (1993-94)
 15. NASA CORE (Source of Audio-visuals and Other Materials)
 16. NASA Satellite Videoconferences (1993-94)
 17. SEEDS Project (Tomato Seeds Flown in Space)
 18. JOVE University Program
 19. Office of Space Sciences and Educational Catalog
 20. Supercomputing 94 Educational Conference
- Enter an option number, 'G' for GO TO, ? for HELP, or press RETURN to redisplay menu...

Figure 34 - NASA Education Programs

Instructional Materials

0. Previous Menu
1. Main Menu
2. Living In Space Activities
3. Space Science Activities
4. Newsletters for Educators
5. Obtaining NASA Educational Publications
6. Astronomy Information
7. Very Lo-Res "Graphics"
8. MarsLink Educational Program
9. Careers in Aerospace
10. NASA Educational Fact Sheets
11. Computer Programs & Graphics
12. Mission to Planet Earth: Catalog of Education Programs & Activities
13. Materials from Outside Organizations
14. 1990-1991 High School Debate Topic Information
15. Liftoff to Learning Series—Educational Videotapes
16. Miscellaneous Classroom Activities
17. Activity Guides for PBS Series: Space Age & Living and Working in Space
18. LIVE FROM...OTHER WORLDS (Interactive Program for Teachers and Students)
19. Mission EarthBound Teacher Resource Guide (MTPE)
20. NASA FOSTER On-line project

Enter an option number, 'G' for GO TO, ? for HELP, or press RETURN to redisplay menu...

Figure 35 - Instructional Materials



Integrated Activity Idea

Pick a spinoff and report what you find to the class. Then develop it into a technical report. Attempt to include economic, social, and historical dimensions.

SPACE PROGRAM SPINOFFS/TECHNOLOGY TRANSFER

0. Previous Menu
1. Main Menu
2. How NASA Technology Transfer Works
3. "NASA Tech Briefs" Free
4. Technology Transfer Projects
5. NASA Areas of Research
6. NASA Patents, Licensing
7. Federal Laboratory Consortium (FLC)
8. Space Spinoff Benefits
9. Current Technology Transfer News

Enter an option number, 'G' for GO TO, ? for HELP, or press RETURN to redisplay menu...

Figure 36 - Space Program Spinoffs/Technology Transfer



NASA Spacelink Frequently Asked Questions (FAQs)

0. Previous Menu
1. Main Menu
2. Questions about NASA, Science and Astronomy
3. Questions about Spacelink
4. Questions about the Internet
5. All of the Above in One Document

Enter an option number, 'G' for GO TO, ? for HELP, or press RETURN to redisplay menu...

Figure 37 - Frequently Asked Questions (FAQ)

9. Of course, you'll need to use Option #1 when it's time to log off. Just follow the commands. That's it. You will soon see that each of these submenus have several layers within them. Some information will be available only on screen. However, there is a considerable amount of information which is available to be downloaded to your computer for your use. It's a tremendous resource for educators who want to incorporate space into their Technology Education programs. And...the students love it!



**Technology
Idea**

Explore the kinds of skills and education NASA requires for employees at various levels across the organization. One way of doing this is through Spacelink. Another way is to do some research into the backgrounds of some of the shuttle's astronauts. Any surprises?

Activity 3



Technology Idea

Have the local HAM Radio group come into your class and give a demonstration of SAREX and other HAM operations. Typically these people are more than willing to share what they know with young people.

Talk to the Shuttle with Sarex

SAREX is the Shuttle Amateur Radio Experiment. With the help of Amateur Radio clubs and ham radio operators, astronauts will speak over the ham airwaves, while in orbit, directly with large groups of students, showing teachers, parents and communities how Amateur Radio energizes youngsters about science, technology, and learning. NASA's intent in making astronauts available for SAREX operations is to involve the largest possible numbers of people, particularly youngsters, in technology and the US space program with the help of Amateur Radio.

The American Radio Relay League (ARRL) and The Radio Amateur Satellite Corporation (AMSAT) co-sponsor these exciting experiments, with AMSAT heading up technical operations. Hundreds of Amateur Radio operators work behind the scenes, including those from NASA's Amateur Radio clubs at the Johnson Space Center, Goddard Space Flight Center and Marshall Space Flight Center. The ARRL provides information and educational support. ARRL Educational Activities Department (EAD) and NASA HQ will create lesson plans for teachers.

You can easily become a part of this activity in your local schools. You will be able to send and receive messages to the shuttle via packet (computer) radio several times daily. The astronauts' work schedules will determine your chances for a random voice message.

A scheduled voice contact can be arranged by applying through the ARRL. These scheduled contacts are limited and are very hard to obtain, due to the large number of applicants, so be patient. It sometimes takes over a year to become a scheduled SAREX school.

All you need to provide is a 2-meter radio or a packet radio setup—which many teachers get from local Amateur Radio clubs. Teachers or instructors can contact ARRL EAD to get a list of local Amateur Radio clubs in your area. They will also send you SAREX lesson plans and regular shuttle news updates. This is a tremendous opportunity for you to showcase SAREX and Amateur Radio to kids of all ages in a big way.

Write to Tracy Bedlack, the ARRL Educational Correspondent at: ATT: Tracy Bedlack, NIQDO Educational Correspondent 225 Main Street, Newington CT 06111 Phone (203) 666-1541 FAX (203) 665-7531

MCI Mail ID: 215-5052 CompuServe ID: 70007,3373 Prodigy: MGTS39A
- Luck Hurder BIX: ARRL Internet (USENET): ead@arrl.org Internet file server: info@arrl.org (valid commands include INDEX and HELP) ARRL BBS: (203) 666-0578 open to the public (14,000/9600/2400/1200/300 N-8-1)



Procedure

1. Set up the computer with the tracking software and load the latest Keplerian set for the shuttle flight that is in progress. This will tell you when the next pass of the shuttle will be within view of your radio equipment. This Keplerian data set is updated daily during a mission on NASA Spacelink. It is important to have current data, due to the small window of time that the shuttle is in range of your ground station. Even a small variation can cause you to miss vital seconds.
2. Connect the 2-meter radio to the TNC per the instructions. (Obtain help from a local amateur radio operator if needed. They may even have the complete station that they will be happy to bring to the school!)
3. Set up the antenna system in an area clear of obstructions. Connect the rotator cable and radio coax and route them to the radio station. Keep the coax run as short as possible, due to excessive signal loss in long runs of coax.
4. Connect the coax to the radio and the rotator wire to the rotator control box. Check the antenna system to insure that it moves freely both vertically and horizontally.
5. Turn power on to the radio and tune to 145.550 MHz (Megahertz). This is the standard transmit frequency for the shuttle (YOUR receive frequency.). Adjust the squelch so that the radio is quiet. For packet you will transmit on 144.490 MHz and receive on 145.550 MHz (an offset of -1.060 MHz). Voice contacts will be received on 145.550 MHz and transmitted on 144.950 MHz (an offset of -0.60 MHz.) The best method for setting these frequencies is to program each set into a memory or channel position in the radio. That way you can switch easily from packet to voice as needed. (NOTE: These frequencies will be different if you are on a SAREX scheduled contact. The ARRL and NASA will notify you of the proper frequencies prior to the schedule.)
6. As the shuttle approaches the horizon, watch the azimuth reading and rotate the antenna to point in the direction from which the shuttle is approaching. As the shuttle clears the horizon, you should start hearing bursts of packet data from the onboard packet robot. If you do not hear anything, the shuttle may be on another frequency with a scheduled contact or the packet robot may be turned off. Be sure that as the tracking program shows changes in azimuth and elevation, you rotate the antenna system to follow those coordinates. This is critical for the best radio signal to and from the shuttle.
7. The callsign of the shuttle packet station is W5RRR-1. On the computer attached to the TNC, enter the message "C W5RRR-1" and hit return. This will send a connect request packet to the shuttle. Once the shuttle has received your connect request, it will send a connect acknowledgment back and you will receive a message that says "Connected to W5RRR-1".



Integrated Activity Idea

Identify where Ham radio frequency waves fit on the sound wave spectrum. How is Ham different from other radio or television transmissions?

8. The shuttle robot will send you a message that identifies your contact or "QSO" number. This number is used to confirm the contact with the ARRL if you request a QSL or conformation card from the shuttle flight. The robot will then automatically send a disconnect message and you will be disconnected from the packet station.

Congratulations on your first earth to space radio contact!!!

Randomly, the astronauts may have free time and be on voice during non-scheduled or open passes. If this occurs, just set the radio to your voice frequency memory, connect the microphone and use the callsign the astronaut is using. All other aspects are the same. These random voice contacts will be short, probably with only an exchange of your school name and location, as there are many other non-scheduled schools and hams that will be trying to reach the shuttle also. A scheduled contact will give you more opportunity to talk with the shuttle. These setup so that you have the whole pass (approximately 6-8 minutes for a schedule.)

This may all seem confusing to the non-amateur. It is advisable to obtain the help of an individual or group of amateurs to assist you in setup and operation of the station. Many amateurs have vast experience with working the shuttle or amateur satellites. They can be the link to making or not making your contact successful. Don't hesitate to ask for assistance. Many hams will be as excited as your group to be able to participate.



Technology Idea

Layout a systems "black box" diagram of the communicating from your station to the shuttle.

Materials Needed

A computer with a satellite tracking program and current Keplerian (orbital element) data for the current STS-XX flight. You can download tracking programs and Keplerian data for the IBM-PC from NASA Spacelink by telneting via MORETech. STS Orbit Plus is a very good program for graphics, but requires at least a 386DX PC with a math coprocessor.

A 2-meter VHF amateur radio with appropriate power supply for voice and packet capable of receiving and transmitting on frequencies amateur frequencies between 144 and 147 megahertz. A minimum of 45 watts is recommended for the radio as to aid the astronauts in getting a strong readable signal from your station. An external amplifier with built-in pre-amp is also useful. The pre-amp will amplify the received signal from the shuttle to your station. These are usually obtainable through a local amateur radio club or individual ham operator. Most hams will be willing to help with this project. (NOTE: An amateur radio license of Technician class or higher is required to transmit on these frequencies.)

A TNC (Terminal Node Controller) for amateur packet radio. This unit is like a modem for amateur radio.

A 2-meter circularly polarized VHF Beam antenna system with elevation and horizontal capabilities, and enough RG-8 COAX to reach to the radio.

A computer with communications software capable of talking to the TNC via a serial interface.

Equipment can be ordered from Amateur Electronics Supply - 1-800-558-0411. Other Suppliers are listed in amateur radio periodicals



Activity 4

Eavesdrop on the Astronauts!

During a shuttle mission carrying the SAREX payload, news and astronaut retransmissions are carried on these Amateur Radio stations: (NOTE: You must live within approximately 30-50 miles of a transmission location to hear the VHF frequency transmissions.)

- Goddard Amateur Radio Club (Greenbelt, MD), Amateur Radio station WA3NAN, news and re-transmissions on high frequency (HF) bands at 3.86, 7.185, 14.295, 21.395, and 28.65 MHz and on VHF at 147.45 MHz.
- Johnson Space Center Amateur Radio Club (Houston, TX), Amateur Radio station W5RRR, news bulletins on HF bands at 3.850, 7.227, 14.2 80, 21.350, and 28.400 MHz and VHF at 146.64 MHz.
- ARRL (Newington, CT) Amateur Radio station W1AW, news bulletins (9:45 PM, 12:45 AM EST) on HF bands at 3.99, 7.29, 14.29, 18.16, 21.39, 28.59 and VHF at 147.555 MHz.

These stations, and several VHF repeater groups (some may be in your area), will re-transmit the signals on most amateur bands so that you and the students can hear the communications. Contact a local amateur radio club to find out if they retransmit the shuttle in your area on VHF. You will hear NASA Mission Commentary, frequent bulletins to advise listeners of astronaut-planned transmissions, and amateur two-way voice transmissions with the shuttles. Using a simple hand-held receiver, you can open the world of science to hundreds of youngsters.

Listen also to the ARRL Bulletins on W1AW (see the ARRL's monthly journal, "QST", for Morse code and voice bulletins) on a daily basis; and to the AMSAT International Satellite Nets on Tuesdays, 3.840 MHz, 0130Z to 0300Z, and on Sundays, 14.282 MHz, 1800Z to 2100Z, +/- QRM.

Procedure

1. Place the antenna per directions as high as possible and clear of any obstructions. Try to keep the coax from the antenna to the receiver as short as possible (under 50 feet preferred).
2. Tune the receiver to the desired frequency. The higher frequencies, such as those on 14 and 21 Mhz will be more reliable during the daytime hours. The lower frequencies will be better during evening and night hours. VHF will be the same 24 hours a day.



Integrated Activity Idea

Chart the frequency spectrum of audible, microwave, HAM bands, CB bands, etc. Explain how these waves work in real life devices such as microwave information transfer and cooking, HAM communications, etc.

3. Transmissions are not 100% continuous, so expect some breaks in between. If nothing is heard on one frequency, try other frequencies. Atmospheric conditions can cause variations in reception at different times.

Materials Needed

For HF reception:

A shortwave receiver capable of receiving frequencies between 3.8 Mhz and 28.8 Mhz for HF frequencies.

A shortwave wire antenna system for reception of HF frequencies. (May not be needed depending on your location and the transmitting stations location.)

For VHF reception:

An FM receiver (scanner or similar radio) capable of receiving frequencies between 144 and 148 MHz.

An external VHF receiving antenna for the above receiver (may or may not be needed depending on the proximity of your location and the transmitting station.)

Radio Shack carries scanners for VHF and Shortwave receivers for HF frequencies and antenna systems for both.

Reference:

NASA Spacelink BBS. Telnet through MORETech or direct dial at 1-205-895-0028. (1200-9600 Baud; 8-N-1)

ARRL BBS. 1-203-666-0578. (1200-14,400 Baud; 8-N-1)



Activity 5

Space Simulation

Most education is based on "know what" or "know that." Technology education is based on "know how." Science asks, "why is it like that?" while we ask, "how can this be accomplished?" To empower students with the technological processes that will allow them to use science, English, math, history, etc. to solve new challenges, the student must be engaged in contextual ("real world") hands on experiences. Thematic simulations are based on the old proverb:

*Tell me and I'll forget (right after the test).
Show me and I'll remember (for a while)
Engage me and I'll understand (empowerment)*

Having an overarching theme adds continuity which mentally allows the students to stay enthusiastic and involved over a much longer period of time than, say, an assignment. Thematic simulations engage students because, being interactive, the exact outcomes of the simulation are unknown. Students don't feel spoon fed (no challenge) or completely left to fend for themselves (too challenged). Instead they feel like they can succeed, but don't know exactly what the outcome will be. This type of experience is empowering and simulates as closely as possible the expectations and environment they will be working in after graduation.

The more "real" this simulation, the more rigorous it can be, and the more exciting it is for the students. In this TAM we will explore Space Simulations. We will start with the least amount of effort and cost and move toward the most time and cost intensive. Space Simulations:

- Excite and empower students.
- Excite parents and industry.
- Excite administrators because students, parents, and industry are excited.
- Generate tremendous energy and support for your program.
- Are very cross curricular.
- Are never the same experience twice.
- Show how the space program impacts everybody's life (spinoffs).
- Have a tremendous amount of support literature, video's, and artifacts available.
- Can be very cost effective.
- Are fun for the teacher, too!

The bottom line is that Space Simulations help young people to more easily make that traumatic transition from school to work.



Technology Ideas

Wherever possible, attempt to involve other teachers and students from other disciplines in your simulation. It could be that your theme will help enrich a part of their program. As much as possible, try to use the simulation to connect learning from various areas of the curriculum.



Technology Ideas

Visit a school which has been involved in space simulations as part of their Technology Education program. There are growing numbers of these in Missouri and across the U.S. Also, look at space simulations articles in the Technology Teacher for additional ideas.

Option 1 - Possible Space Simulations

Watch Videos from NASA based on the objectives you want to cover, put students into a simulation where:

- They are given real world jobs with real world expectations and outcomes.
- The tapes play a key, but not total part in the research process.
- The expected outcomes are so tight that the students simply "chug and plug", instead of using creative thinking.
- The expected outcomes are so loose that the students don't have a clue what to do or where to start.
- English, math, science, history, etc. are all expected to be a part of the final product.
- They have some document (rubric) that clearly defines the "white lines" of the project.
- There is no one correct answer and lots of room for creativity.

Some examples of possible space simulations follow.



Integrated Activity Idea

Involve the foreign language students and department. Have an ESA (European Space Association) satellite bread down and your students have to talk to the ESA mission control in a foreign language to fix the satellite's malfunction.

1. Your students are marketing people looking through NASA's technology for new public products (spin-offs). They can watch the tapes as marketing teams. Discuss possible options. Pick a product and present a presentation to "the stock holders" (could be Industry, staff, and peers). The presentation could include history, market research, drawing, models, marketing plans, budgets, etc. The stock holders would decide whether to fund the project or not.
2. Students could be representatives from all over the world who are members of a world organization on world ethics. Watch video's from NASA, public health, industry, other nations, etc. and consider ethical questions about man's space exploration. Some questions to consider might be:
 - Is the money spent on the space program worthwhile?
 - Should those funds be spent other places instead?
 - Are manned space flights necessary when robots are less costly and less risky?
 - Is all the debris left in space a potential problem to future space travel?
 - Should space exploration be multinational or just American?
 - Is it okay to have the Golden Arches on the moon visible from earth?
 - Who owns what part of space and what are you allowed to do with your space?
 - Have your world ethics organization meet, discuss the chosen topic, arrive at a decision and print out a document stating their positions.



3. Be historians looking for the causes that lead to the "space race" and how it has impacted our society.
4. Be an add agency who is hired by NASA to promote the next mission in your town. How would you generate public awareness and interest? You could use these same strategies to promote your own missions.

Option 2 - Software Simulation

There are several companies who have wonderful aerodynamic, aerospace, and space related software on the market. Microsoft is presently working on an interactive space simulation that will allow you to fly anywhere in space you want.

Take the package of your choice, use the bullets in option 1, and devise a theme for your students. See the resource section for some software vendors, and software packages.

Option 3 - Space Field Trip

Field trip to an institution or industrial site that demonstrates or utilizes aerospace or aerodynamic principles or process. This is not a simulation but is great background for students to use in a simulation.

You might have a local industry or industry near you that has some direct connection to aerospace or aerodynamics.

There are many Missouri institutions like:

- St. Louis Science Center/Planetarium
- Whiteman AFB/Stealth, Missiles Tour
- CMSU/Skyhaven Airport, fly trainers visit facilities/aviation program
- Huntsville, AL, Marshall Space Flight Center
- Military Recruiter Visit or Demo
- Participate in a teleconference with NASA
- Visit a school who had a simulation lab

You could also participate in a NASA teleconference or go to visit a school that has a simulation lab.

Option 4 - Link to ISSS Mission

Make the proper data or video links and watch an ISSS mission. If properly connected, students could question the "astronauts" real time during the mission.

Option 5 - ISSS Tech Specialists

1. Make contact with the ISSS and have your students become "tech specialist" for a mission. For example, have your students pick a space system they would like to know about. Once they are knowledgeable, they could be written into the mission to help solve a SOBE (simulated on board emergency). When the system has a malfunction, mission control would call your students for expert advice to help the astronauts prepare that system on the ship. It could be anything from communications to navigation to propulsion and to waste management.



Technology Idea

Contact MORETECH, ITEA, MVA or the Missouri's State Supervisor for possible contacts for space simulation contacts.



Integrated Activity Idea

Design a space logo for your sim lab. This could be a competition which is school-wide with a reward for the winning design.

2. Or, you could be medical technology specialist. Before the mission you could be given all the base line medical data on the astronauts. During the mission you would get regular vitals updates. You could compare these with the base line data for any possible problems. On the first day of our last mission, some middle school medical specialist realized that due to the stress of our astronauts spending 3 days and 3 nights together with people they hardly knew that all the astronauts were running low grade fevers and had elevated respiratory and heart rates.

Option 6 - ISSS Experiment

Have your students design and build an experiment for an mission. Have your students research, design, and build an experiment that will be performed during an ISSS mission. The students could send the package to another site and watch the experiment to be performed over TV or could some how have remote control in their lab to perform the experiment on the ship at a remote site.

Option 7 - ISSS Remote Site

Be a remote site for an ISSS mission. A part of the larger mission. Your students could be lunar base, a mars base, a cargo asteroid, a shuttle, almost anything. You could outfit a room or build a temporary structure and be a part of the ISSS mission.

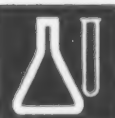
At this point you have made a serious commitment in time, space, and money. However, the educational processes and energy level of participation goes up dramatically.

The best way to do this is to visit other space simulation sites and get first hand what an experience like this has to have to be successful.

Option 8 - Your Own Simulation Lab

Build a space simulation laboratory of your own. This is a time consuming and laborious act of love. It needs to be well planned and supported by students, parents, administration, and industry to work as it should.

I know of nothing that will engage students more in the educational process than a simulation lab. Be sure to maintain as much flexibility as possible because every year the technology will change. Be unabashed about soliciting funds for your students and program, but remember, it should be a two way street. The donor needs something they perceive as valuable in return. This may be only the great feeling that they are helping kids. No matter what, be sure that everyone who helps is kept up to speed on how things are doing, have gone, and will go in the future. A newsletter produced by your students is a great method of maintaining your communications and teaching students how to desk top publish.



Integrated Activity Idea

For Option 6, refer to TAM 5 for possible space-biotechnology related activities. Activity 6 on gravitropism is particularly well suited.



Assessment

Scoring Rubric for Activities 1-5

Performance Standard	Wgt %	Exemplary 2 pts.	Acceptable 1 pt.	Not Yet Acceptable 0 pts.	Sub total
I. Creative Thinker					
Project future technologies which could be expected to emerge from space exploration and travel.	x.5	Per Activity 3 (SpaceLink), student correctly projects future technology based on current space exploration and travel.	Student uses hard copy literature/periodicals to correctly project future technologies based on current space exploration and travel.	Student does not project future technologies that are based on current space exploration and travel.	2 x .5 = 1
List and describe the various applications of space technology, including everyday, specialized, and future uses.	x.5	Per Activity 3 (SpaceLink), student correctly describes the various applications and uses of the shuttle.	Student uses hard copy literature/periodicals to correctly describe the various applications/uses of the shuttle.	Student does not correctly describe the various applications and uses of the shuttle.	2 x .5 = 1
II. Critical Thinker					
Recognize and analyze the potential positive and negative impacts of space exploration, development, and travel on society.	x1	Students successfully debate/roleplay the positive and negative impacts of space exploration, etc.	Students submit a written assignment detailing the positive and negative impacts of space exploration, etc.	Students do not correctly recognize and analyze the positive and negative impacts of space exploration, etc.	2 x 1 = 2
III. Contributing Citizen					
Practice all safety procedures when interacting with space-related equipment and procedures.	x1	Per Activity 1, Student practices all safety procedures related to constructing/launching his/her rocket and encourages others to do so.	Student practices all safety procedures related to constructing/launching their rocket.	Student does not always practice safety procedures related to constructing/launching their rocket.	2 x 1 = 2
IV. Self-Directed Learner					
Identify typical industrial, educational, and societal sectors that may benefit most from the products, knowledge, and designs of the space industry.	x1	Per Activity 2 (Option 1), the students' company successfully presents (90% success rate of preset criteria) a new project and receives approval from the "Board"	The "company" receives support on 70% of the preset criteria from the board but is "encouraged" to resubmit their proposal for 90% success rate.	The "company" receives less than 70% support of the preset criteria from the board and is encouraged to resubmit their proposal.	2 x 1 = 2
V. Problem Solver					
Develop a design for and solve problems related to constructing a simple, deployable space station simulation.	x2	Per Activity 2 (Option 1), the Student designs/solves problems for deployable space station simulation with a 90% success rate of the preset criteria.	Student designs/solves problems for deployable space station simulation with a success rate of 70% of the preset criteria.	Student achieves a success rate of less than 70% of the preset criteria.	2 x 2 = 4
VI. Effective Communicator					
Communicate orally, visually, and/or in writing the principles of actual and potential space travel.	x1	Student orally presents an aspect of space travel (meeting all criteria) with no errors (all students report on different aspects that comprise a unit).	Student orally presents an aspect of space travel with 70% accuracy.	Student orally presents an aspect of space travel with less than 70% accuracy.	2 x 1 = 2
VII. Quality Producer					
Construct a model space station simulation.	x2	Per Activity 2, (options 6-8) students successfully complete criteria with 90% accuracy.	Students successfully complete 70% of the preset criteria of the space station simulation.	Students successfully complete less than 70% of the preset criteria of the space station simulation.	2 x 2 = 4
VIII. Technical Foundations					
Identify the various foundation skills and possible career options in the aerospace industry.	x.5	Student gathers information from literature (3 different sources) and identifies 3 possible career options.	Student gathers information and identifies 1 possible career option from 1 literature source.	Student does not correctly identify any possible career options or does not use proper sources.	2 x .5 = 1
Define those practices and terms used in space programs, including NASA, satellites, space stations, skyways, and space structures.	x.5	Student achieves 90% mastery of a written or verbal essay exam.	Student achieves 70% mastery of a written or verbal essay exam.	Student achieves less than 70% of a written or verbal essay exam.	2 x .5 = 1

Total: 20 out of 20 Possible

Performance Checklist for Activity 4 - Eavesdrop on the Astronauts

- 4 = Excellent (student successfully completes activity & displays mastery of subject/content/skill)**
- 3 = Good (student completes activity with good quality/knowledge of skill)**
- 2 = Needs Improvement (student completes activity without demonstrating mastery of subject matter or activity performance requirements)**
- 1 = Not Acceptable (student does not yet successfully complete the activity, needs additional work)**

1. Student comprehends the prerequisites of receiving transmission (i.e., proximity of receiving transmission, locating amateur clubs for information, etc.	4	3	2	1
2. Student correctly designs antenna, including location, height, placement (orientation) and distance away from receiver.	4	3	2	1
3. Student receives approval from teacher on antenna design prior to beginning construction.	4	3	2	1
4. Student correctly constructs antenna, following design set forth in step 2.	4	3	2	1
5. Student correctly tunes receiver to desired frequency.	4	3	2	1
6. Student correctly identifies receiving problems, if applicable.	4	3	2	1
7. Student correctly solves receiving problems (i.e., corrects antenna placement/location, resets frequency, length of coax from antenna to receiver, etc.), if applicable.	4	3	2	1
8. Student receives transmissions from astronauts and submits written transcript of transmission.	4	3	2	1

Note: This assessment can be used as a peer, self or instructor tool.



Name _____

Affective Self and Peer Assessment

For each of the criteria, assign a rating to each member of the class or technology group (including yourself) on a scale of 4 - 0. (4 = excellent, 3 = good, 2 = average, 1 = poor, 0 = unsatisfactory.)

	Student A	Student B	Student C
Initiative (ability as a self-starter, self motivated)			
Use of time (consistently on task, productive, efficient)			
Reliability (regular attendance, carry tasks through to completion)			
Work quality (tasks and operations were well done)			
Idea quality (good problem solving skills and ideas)			
Ability to work with others (ability to share tasks, contributing team member)			
Overall knowledge of space			
TOTALS			



Instructor Resource

The Final Frontier

Content Outline

1. Space Environment
2. Orbital Mechanics
 - Space Shuttle Overview
 - Space Station Overview
3. Computer Basics
 - Data Processing System-Shuttle
 - Data Management System-Station
4. Space Communications
5. Shuttle Systems
 - Electrical Power Systems
 - Thermal Control Systems
 - Propulsion Systems
 - Guidance, Navigation, and Control
 - Human Systems, Designing for Humans in Space
 - Environmental Control and Life Support Systems
6. Robotics in Space
7. Careers & Opportunities

Instructional Resources

Books

Aerospace Resources For Science and Technology Education, ITEA, 1914 Association Drive, Reston, VA 22091

Katzenbach, Jon & Smith, Douglas. *The Wisdom of Teams*. Harper Collins.

Thorne, Kip S. *Black Holes and Time Warps: Einstein's Outrageous Legacy*.

The Satellite Experimenters Handbook. ARRL 1-203-666-1541

Now You're Talking: Discovering the World of HAM Radio. ARRL

The ARRL Handbook for Amateurs. ARRL 1-203-666-1541

Magazines

Air and Space Simulation, P.O. Box 53261, Boulder, CO 80322-3261

Amateur Television Quarterly, 1545 Lee Street, Des Plaines, IL 60018, (708)298-2269
Voice, (708)803-8994 Fax

Aviation Week and Space Technology. McGraw-Hill.

Flying. Diamantis Communications, INC.

73 Amateur Radio Today - Subscription Services 1-800-289-0388 or local newsstands.

NASA Tech Basics, 41E, 42nd Street, Suite 921, New York, NY 10017-5391

OMNI. Omni Publications International.

QST - Subscription with ARRL Membership 1-203-666-1541

Sky and Telescope. Sky Publishing Co.

Spirit by McDonnell Douglas, Editor, Spirit, Mailcode 1001195, P.O. Box 516, St. Louis, MO 63166-0516, (314)232-5326

Electronic Resources

Microsoft Flight Simulator, Microsoft Space Simulator. Microsoft Corp.

Space Link

Dreams of Flight - Smithsonian Video

"To the Moon and Beyond"... 2 Video Sets, Sun West Media, 1801 Oakland Blvd., Suite 315-M, Walnut Creek, CA, 94596-7000, 1-800-466-7766



Glossary

ARRL - American Radio Relay League is the organization who licenses HAM radio operators so they can broadcast over amateur radio frequencies.

Baud - Actually Baudrate which is the speed in information per second your modem can send and receive digital information. The higher the baudrate the more information you can process or transfer per second.

INTERNET - computer network comprised of multiple individual connected user links or individual networks. A world wide information highway.

Keplerian elements or set - navigational coordinates of the shuttle's present orbital position. Named after the German astronomer Johann Kepler (1571-1630).

Modem - the hardware that talks back and forth from your computer to any other modem which is attached to a computer. The term stands for Modulation-Demodulation.

MORETECH - a Missouri state supported computerized bulletin board system designed to provide a communications link and bank of electronic resources for Technology Education teachers and students.

SAREX - Shuttle Amateur Radio Experiment is the program that allows students and teacher to talk real time to shuttle astronauts while they are in space.

Spinoffs - products that are developed as part of the aerospace program but are very useful in the private sector as well (superglue, global positioning systems, composite materials, etc.).

TELNET - a syntax command which allows communications users to log on to remote Internet sources

TNC - terminal node controller - a piece of hardware used like a modem only for amateur radio packet transmission.

Safety Factors

As with all events in real life you should always be acutely aware of potential safety hazards. With rocketry it is important to keep the following factors in mind:

- **Assembly:** Eyes, burns, and cuts are major concerns.
- **String test:** Rockets being string tested can come loose and do serious damage to people or things, designate a string test site, safety glasses are mandatory, and extra people should stay away.
- **Rocket engines:** Can cause major harm. They will explode due to heat or compression. A sharp blow to the engine even during the string test could cause an accident.
- **Launch:** Be sure to have rocket shielded and students well away. If an engine explodes prematurely with the rocket only a few feet off the ground, the rocket becomes a hand grenade. Most companies that sell rocket supplies have adequate safety sheets.
- **SAREX:** As with all electric equipment, there is always the chance of electric shock.
- **Simulations** probably have just about every safety consideration known to man. The safety procedures will be directly proportional to how large your project is and how involved you build the project.

Instructional Suggestions

Motivation

- These activities offer alternatives to sitting students in neat parallel rows of desks like lobotomized zombies whose heads are unscrewed by boredom so that teachers' favorite discrete facts can be poured in through drill and kill exercises. The students can then regurgitate these facts on paper and pencil tests every Friday. This allows them to perform a short term memory dump before their weekend frolic. In this way the teacher can honestly assign a passing grade to students who tried but no longer know the information.
- Instead, students are seduced by themes that are not only relevant to their success in the real world, but also in their immediate world as well. Other disciplines start to make sense because students have hands-on concrete experiences to apply the theory to. It is challenging and fun.
- You become the facilitator of the process. Just like a coach who, knowing the correct process, can train athletes to much higher achievement levels than his/her own levels, you can engage students to develop those critical algorithms needed for personal success.
- Read the new handbook carefully; it is a treasure chest of educational jewels that will allow you to change your methods and empower your students for life.

Prerequisite Information

An interest in space and a willingness to learn.

Demonstrations

- String test on rockets
- Firing sequence on rockets
- Logging on to Spacelink
- Ham Radio Use Demonstration including system operation rules

Academic Enrichment

- Involve students in formulating their learning objectives and identify where these connect with Missouri's Performance Standards.
- Have students get involved in designing the science experiments which they will do on the space mission.

Related TAMS

- Introduction to Energy and Power Technology Guide
TAM 7 Adventures In Flight
- 1990 Implementation Workshop TAMS
TAM 5 Egg Rockets
TAM 4 Hot Air Balloons
- 1991 Implementation Workshop TAMS
TAM 1 Flight Technology and Aerodynamics
- Performance Standards Project
TAM 1 Lighter Than Air



Assessment Suggestions

- The ultimate acid test for assessment is the ability to transfer skills, knowledge, and processes to a totally new and different challenge or problem.
- The other critical assessment should be how well students can assess the quality of their own and others' products or processes.
- Use a rubric to start the theme. This will clearly define the "White Lines" of performance and allow the students to know what constitutes a quality product.
- Then engage them on a regular basis (at least weekly) to critique their progress, performance, and product.
- In the end have the students assess their own product and every peers product as well. Use 1 class period, have an assessment form and give each student 2-5 minutes per project.
- Then have each student assess how well the other students assessed their product. Be sure to have them justify this assessment.
- As a culminating exercise ask the students to apply the process they went through to a completely different challenge. I often use this as the lead in to either another subsystem of the theme, another cluster objective in the theme or as a take home final to sum up the experience at the end of the theme.

Note: Review the assessment items which are presented throughout the Performance Standards TAMS for ideas which can be adapted for this TAM. You should also refer to the Performance Standards Education Implementation Handbook for additional assessment examples and ideas.

Summary

Technologists, more than most, have always taught performance standards. Unfortunately, we teach students in an order of knowledge instead of empowering them through the order of learning. Themes allow students to constantly stretch their comfort zones and experiment as they hone their skills and abilities to solve daily in context challenges. If your program is losing student numbers and parent support, you should think seriously about breathing new vigor into it with a rigorous interdisciplinary "real world" thematic approach.



By Lynn Diel

Technology On Line

Goal

The goal of this TAM is to provide the fundamentals and hands-on experience with basic procedures used to in data communications and telephony.



Mathematics



Communications



Science



Social Studies



Fine Arts



Health



Technology

Performance Standards

- Speculate the future of various areas of telecommunications and telephony, including digital, analog, and visual communications.
- Identify and appraise the hazards involved in connecting telecommunications equipment together.
- Differentiate between the various protocols (hardware and software) in communications.
- Comprehend how telecommunications impacts and affects society and the everyday lives of its citizens.
- Recognize and analyze the potential positive and negative impacts of telecommunications.
- Explain, illustrate, and demonstrate how a complete communication setup operates.
- Solve problems related to a telecommunications project.
- Apply basic electrical/electronic terminology as it pertains to telecommunications and telephones.
- Communicate orally, visually, and/or in writing the principles of telecommunications.
- Demonstrate the safe use of equipment, supplies, materials, and processes that are related to telecommunications and telephone instrumentation.
- Identify the various foundation skills of telecommuting and how they are used by society.



Introduction

Telecommunications and telephone networks in the world are one of the true wonders of modern society. Both have the capacity to connect two or more of the four hundred million communications lines together typically within seconds. The world's largest network of interconnected and cooperating computers provides the control to these lines. Yet, these lines may be accessed by unskilled operators without formal training. This TAM is one part of the activities your instructor will share with you while introducing you to the highways of tomorrow.

This TAM's purpose is to introduce fundamental concepts of Telecommunications and Telephones. You will learn the basic principles of constructing your own FM antenna (a basic component in wireless communication), how to access a public Bulletin Board Services (BBS), and how to upload and download files from the BBS. In addition, you will see how to establish communication between personal computers using a Peer-to-Peer link.

Communications continues to play a significant part in the success of humankind's technological achievement. For without the ability to pass ideas freely among each other, the world would still be consist of many countries, each doing their own research. A major part of the technological knowledge explosion can be attributed to communications. As the burst of knowledge continues to drive humanity into the next century, your ability to access and use this technology medium will provide you with the information you will require to live a "well-informed" life.

Objective Statement

The activities described in the following pages represent samples of activities which can be used to deliver these performance standards. Many additional activities can and should be used. Extreme care should be taken to connect each activity with appropriate activity objectives as well as with the performance standards on page 1. These objectives should be developed by the instructor and should be shared with and made clear to the students.

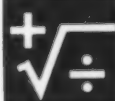


Technology Idea

Visit a TV or radio station to see how a professional production is put together. Explore (with the manager or knowledgeable technician) what kind of skills, educational background, interests, etc. are involved in careers in various aspects of the organization.

Activity 1

FM Antenna Design



Integrated Activity Idea

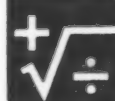
Work with your Mathematics instructor in doing the math components. How is the metric system used in electronics and engineering?

The purpose of this activity is to construct an FM radio antenna that is specially designed to pick up one specific station. The only information you will need to begin is the radio frequency (98.3, 106.1, etc.) of your favorite radio station. To emphasize the importance of this activity, you may wish to choose a station that is on the "fringe" of good reception. As an example, we will use a radio station in St. Louis, KSHE 95.

Procedure

You would like to listen to KSHE, 94.7 Mhz in St. Louis. The problem is that you live on the fringe area where the antenna in your FM receiver will not pick up the signal. You called the engineer at KSHE and he advised to construct a half-wavelength antenna to increase the signal strength.

The half-wavelength (a.k.a. half-wave) antenna is a popular antenna used in the communications industry. It derives its name from the fact that the antenna length is approximately one-half the wavelength of the signal. This basic antenna is called the half-wavelength dipole antenna.



Integrated Activity Idea

Work with the Math and Science instructors in discussing the concept of triangulation.

Key Concepts

$$\text{Wavelength in meters} = \frac{\text{Speed of light in meter/second}}{\text{Frequency in Megahertz}}$$

The study of Physics has determined that the speed of light in a vacuum travels at 300,000,000 meters/sec. Since radio waves travel at or near the speed of light we will use this number as the numerator.

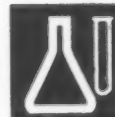
Since KSHE frequency is 94.7 Mhz, we now have all the information to solve the equation.

$$\text{Wavelength in meters} = \frac{300,000,000}{94,700,000} = \frac{300}{94.7}$$

Note: extra zeros drop out

$$\text{Wavelength} = 3.16789862724 \text{ meters}$$

This is the length of one cycle of the FM signal at this particular frequency (KSHE 95). The optimum antenna length would consist of a wire this length stretched at a right angle to the transmitter. Since an antenna of this length (10 ft, 4 and 7/8 inches) can be somewhat impractical, an alternative design should be sought.



Integrated Activity Idea

Work with your Physics teacher in determining the speed of light. Discuss wavelengths and the electromagnetic spectrum.



Radio engineers found that they could fold the antenna in half and still maintain approximately 95% of the signal strength. This design is called the half-wavelength dipole antenna. To convert our wavelength (antenna length) to a half-wave, you will need to divide by two.

$$\begin{aligned} 1/2 \text{ wavelength} &= \frac{3.16789862724 \text{ meters}}{2} \\ &= 1.58394931362 \text{ meters} \end{aligned}$$

Converting this to English measurement, we can see that an antenna cut to 63.35 inches would provide the maximum signal to the FM receiver.

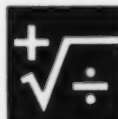
If you look at the back of the FM receiver or review the documentation that accompanied your receiver, you will notice that there is a 300 Ohm antenna input. This represents the amount of resistance that is supplied to the incoming FM signal. This load is required to transfer the signal to the electronic circuitry. Flat antenna wire, which has a 300 ohm impedance, can be purchased from various electrical suppliers (ie. Radioshack).

To construct the antenna, you will need to cut a length of wire 62.85 inches long (note: the additional 1/2 inch will be used for connections).

After you have cut the cable to length, fold the cable in half. Cut one of the wires and dress the wires (See Figure 1). Cut another piece of the 300 ohm flat wire to 72 inches. Strip off one-half inch from each wire on one end. On the other end cut the center part out and strip off one-half inch. This will be the download to the receiver.

Margin of Error

As you construct the FM antenna, care should be taken in marking and cutting the wire. Each station on the FM dial is separated by 200,000 Hz or 0.2 MHz. In reviewing the commercial FM frequency spectrum, we can see that it covers a 20 MHz bandwidth (88 to 108 MHz). If we calculate the optimum length needed for each end of the frequency band, we can see that these distances are 67.16 for 88 MHz, and 54.72 for 108 MHz. By subtracting the two numbers we obtain an overall distance of 12.44 inches which covers the 20 MHz between the two frequencies. If we divide the frequency spread by the overall distance we obtain a frequency of 1,608,121.82 Hz per inch. If we divide this by eight, we obtain the frequency per 1/8 inch (201,015 Hz). From the above calculation, you can see that an error of .125 (or 1/8) inch would cause the antenna to be off by one station separation. This is typically not critical in rural settings where FM stations are several megahertz apart. However, in the more densely populated areas, stations tend to be closer together.



Integrated Activity Idea

In electronics you will often hear the term nanosecond. Just what is a nanosecond? Have you ever stopped and wondered about this time frame?

From the study of physics, we know that distance is the product of velocity times time or $d=vt$.

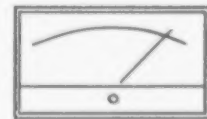
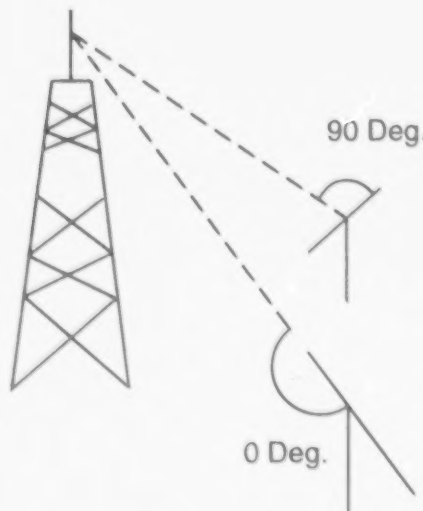
*Distance traveled = Speed of light * one billionth of a second by an electron. Substituting in the numbers we get :*

So the distance an electron traveled in 1 nanosecond is 29.9792458 centimeters. Cut a piece of wire to this length and you will have a visual aid to show your students.



Technology Idea

Experiment with two or more antennas and compare signal strength. Connect them so one is located above another to form a stacked array. Connect two antennas in parallel. Orient the antennas so that each is at right angles to the other.



SIGNAL STRENGTH

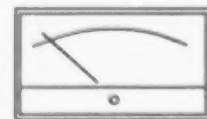


Figure 1 - Orientation of Antenna



Technology Idea

Use the antenna to triangulate a remote FM radio transmitter. Since TV signals are FM, construct a folded dipole antenna for a UHF station.

Installation

Connect the antenna to the receiver. Orient the antenna at a right-angle to the transmitter for best reception. Place a dab of silicone caulking or dab hot glue over the exposed ends of solder connections. **Instructor Checkoff** ☐

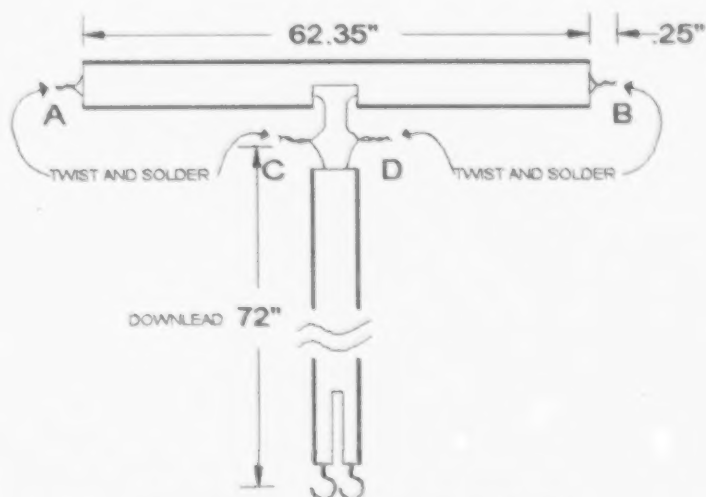


Figure 1 - Antenna for KSHE, 94.7 Mhz



Materials Needed

Supplies

12 ft. Twin lead (300 ohm)

Silicone Caulking OR

Hot glue stick

Rosin core solder

Remember that 1 meter = 39.3701 inches

Equipment

Solder pencil (12-20 w)

Hot glue gun

Wire cutters

Wire strippers

FM receiver

Activity 2

Peer to Peer Communication



Technology Idea

Have your computer science teacher explain the difference between serial comm. and parallel comm. (ports, etc.).

Peer to Peer communications is one of the methods that will play an ever increasing part in how we live in the future. The ability to send documents and files to other people will expedite the information that will flow along the data highways of tomorrow. This activity will provide you with the basic principles and components needed to ensure a telecommunication session.

Procedure

For this activity, you will need two personal computers with either a communications package installed on the hard drive (Procomm, etc.) or available on floppy disk drive. You will also need a null modem cable. (See TAM 12, 1990 ITE Workshop series or purchase from a computer vendor.)

1. Place computers close enough together so they can be connected with the serial null modem cable.
2. Connect the serial null modem cable to an available serial port on each computer. Be sure to note the serial port number for each computer, as you will need this information later during the software setup stage.
3. After properly connecting the computers, apply power to the Personal Computer (PC), and video screen and wait until the operating system has loaded.
4. Invoke the communications program by inserting the disk into the appropriate drive and issue the following command: A:> PROCOMM (or B:> PROCOMM).



You will be greeted with the following screen (see Figure 3).

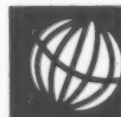
PROCOMM

Version 2.4.3

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Integrated Activity Idea

Work with your Social Studies instructor and discuss the proper behavior and etiquette for accessing public forums.

Figure 3 - Opening Screen

5. Press and hold down the ALT key and then press "S" for the Setup menu. The program will respond with the following screen (see Figure 4).

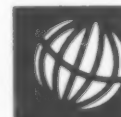
- 1) MODEM SETUP
- 2) TERMINAL SETUP
- 3) KERMIT SETUP
- 4) GENERAL SETUP
- 5) HOST MODE SETUP
- 6) ASCII TRANSFER SETUP
- 7) SAVE SETUP TO DISK

Figure 4 - Setup Screen

6. Enter 5 and press the [ENTER] key. The program will then respond with the following screen (see Figure 5).

- 1) Host ID string.....Welcome to ProComm Host!
- 2) Auto answer string...***++***ATSO=3!
- 3) Host mode password...PASSWORD
- 4) DOS shell password...SHELL
- 5) Auto baud detect...NONE
- 6) Connection type.....MODEM

Figure 5 - Host Mode Screen



Integrated Activity Idea

Work with your Social Studies instructor and discuss the ethics of compromising passwords and/or the behavior of an electronic guest.

7. This screen displays the current setup for the HOST mode. For this exercise you will need to change the Connection type from Modem to Direct.
8. To perform this task, issue the following command: 6 [ENTER]
9. Pressing the SPACEBAR will cycle the selection to DIRECT. When direct is highlighted at the bottom of the screen press the ESC (escape) key. This will return you to the operating screen.
10. Press and hold down the ALT key and press "P" for port setup. The program will respond with the following (Fig. 6). You should choose the COM port to which you connected the serial port (step 2).

LINE SETTINGS

CURRENT SETTINGS: 9600,N,8,1,COM1

1) 300,E,7,1	7) 300,N,8,1
2) 1200,E,7,1	8) 1200,N,8,1
3) 2400,E,7,1	9) 2400,N,8,1
4) 4800,E,7,1	10) 4800,N,8,1
5) 9600,E,7,1	11) 9600,N,8,1
6) 19200,E,7,1	12) 19200,N,8,1

Parity	Data Bits	Stop Bits
13) ODD	16) 7 bits	18) 1 bit
14) MARK	17) 8 bits	19) 2 bits
15) SPACE		

20) COM1	21) COM2	22) COM3	23) COM4
----------	----------	----------	----------

24) Save changes
YOUR CHOICE:

Press ESC to return

Figure 6 - Line Settings Menu

11. When your counterpart has performed the same task on his/her PC, you should be able to type on your keyboard and have it displayed on the other PC. Note that you cannot see what you have typed at this time.

This is the first level of communications. The next level is to modify your setup so that you can put the Peer-to-Peer connection to effective use.

12. Press and hold down the ALT key and then press "E" for a local Echo mode. This will tell the program to display the text on your local machine as well as sending it to the remote PC. (Have your counterpart do the same thing.)
13. Press and hold down the ALT key and then press "F3" to toggle the program from "CR" mode to "CRLF". This will tell the program to send a linefeed to the remote display as well as your PC. (Have your counterpart do this.)



After you have performed the above tasks, you should be able to communicate with the other PC. **START TYPING!**

After you and your counterpart started typing, you probably noticed that it was hard to determine who sent what. To alleviate this problem, common rules for data communication should be used. These are not etched in granite so you are free to modify them to suit your needs.

- One person uses uppercase letters, the other uses lowercase letters.
- Send two linefeeds at the end of your message or use the word "-over" to indicate you are transferring the message to the other person.

Alternatively, you could use the bell command to indicate you are finished with your message. This is sent by pressing and holding the Control key and then pressing the "G" key.

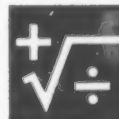
The next portion of this activity is for one of the computers to emulate a Bulletin Board System (BBS). To do this, we will use a feature of Procomm called "host." The purpose of the "host" command is to "open" the host computer's files and information to the other user.

14. After you have established communications, decide via the keyboard who is going to be in HOST mode first.
15. Once this has been determined, the person who is going to be the HOST should issue the following command by issuing the following command: **ALT - Q**

NOTE: Only one person should issue this command!

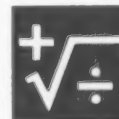
16. The other person should receive an informational screen indicating — Welcome to PROCOMM Host!
17. Enter your full name at the request and press the [ENTER]
18. You will be prompted for a password. **Please note that the system will only respond to UPPERCASE letters. Press the CAPS lock to switch to uppercase.**
19. Enter the password. This was located earlier when you entered the HOST setup. The default is **PASSWORD**.
20. The system will respond with a series of commands:
F)iles C)hat D)ownload U)pload S)hell G)oodbye
21. Your next task is to download a file from the remote system. Select the download option **D**.
22. The system will ask for the filename. Enter **A:\PROCOMM.EXE**, or other filename of your choice.

Auxiliary Step: Select the chat command and again establish a discussion with the other party. When you have finished, the person in the HOST mode should press the ESCape key to exit.



Integrated Activity Idea

Work with the Math instructor to calculate the speed of transfer of data using eight bits of data, one start bit and stop bit.



Integrated Activity Idea

Ask your math instructor about binary number systems, boolean algebra and the speed of data transfer.



Technology Idea

Using this method will allow you to transfer files from one PC to another where other means are not possible.



Integrated Activity Idea

Do a historical investigation of the development of the computer. Who were the key people involved? What factors contributed most to its development? Why was digital logic chosen? What would you say has been the single most important social impact of the development of the computer?

23. The system will respond with the following messages asking you to choose your preference for a file transfer protocol.

K)ermit M)odem7 T)elink X)modem Y)modem batch

Your Choice?

Kermit is the most reliable transfer software protocol, but it is the slowest due to packet size limitations. X and Y modems are considerably faster than the rest due to their robust packet size. In addition, Y modem supports multiple file transfer. Y modem allows the user to send multiple files sequentially (batch mode) to the host.

24. Select the Xmodem protocol by issuing the X command.
25. Type in the specifications of the file you wish to download, including the drive, path and file extension. Press the **PGDN** (page down) key and select Xmodem. Press the **[ENTER]** key.
26. After you have successfully downloaded a file, issue the Upload command and send a file to the HOST unit.
27. After you have Downloaded/Uploaded files, close communications and have the other person perform the same tasks.

Materials Needed

Supplies

RS232C Cable
2/3 Switcher

Equipment

2 MS/DOS PC's
Procomm 2.X or other
communication software

(You may substitute any other computer instead of using MS/DOS PC's, however, you will need to obtain the proper communication software.)



Activity 3

Accessing a BBS

Prospecting for information and programs by accessing a Bulletin Board System can provide for a wealth of information. There are Freeware, Shareware, and Nagware programs that cover the every aspect of everyday lives. Those who can access this information rapidly and easily will have the opportunity in the future to be on the leading edge of the information highway.

One of the newest BBS services being provided for those who are interested in technology and how we learn to harness the power and responsibility that ensues it, is MORE-Tech. This BBS system is funded by the Department of Elementary and Secondary Education and the Technology and Industrial division. From this system you will have access to BBS system all over the world. You can send mail to students in Europe, Asia, Fiji, or just about anywhere on the planet.

Procedure

Logging onto a BBS

1. Ensure that power is applied to the Personal Computer (PC), Modem, and video screen.
2. Invoke the communications program by installing the disk into the appropriate drive and issuing the appropriate command. (See activity 2)
3. Log onto MORE-Tech. This can be done via any internet service. The following is an example of accessing MORE-Tech via 800 number dial up. You will need the modem information in Figure 7.

MODEM INFORMATION:

Phone number:	1-800-xxx-xxxx
Settings:	no parity
	8 data bits
	1 stop bit
emulation:	vt100
Speed	Based on your modem and software

Figure 7 - Modem Information



Technology Idea

Using a computer and a modem, log on to the internet and complete the Scavenger Hunt which is presented on page 24. Be certain to keep track of the addresses and procedures used to access each item. These will help you retrace or extend your future searches.



Integrated Activity Idea

Obtain user id information from someone who works in an area which interests you, perhaps for a potential career. This could be a scientist at a major research laboratory, a university professor, another student, an engineer, a politician, etc. Use the internet to correspond with the individual for technical information, general questions and answers, etc.

Logon Procedure:

4. Dial the phone number.
5. You will see the following lines on your screen;
CARRIER *your modem speed*
PROTOCOL: LAP-M
COMPRESSION: BV.42BIS
CONNECT *your modem speed*
6. Touch your enter/return key to proceed and the following lines will appear:

Annex Command Line Interpreter * Copyright 1991 Xylogics, Inc.

Checking authorization, Please wait...

Annex username: type in your Sprint username

Annex password: type in your Sprint password

Permission granted

.....

Welcome to Sprintlink

Any unauthorized use is strictly prohibited. Please contact Sprintlink

Network Operations Center at 1-800-669-8302 for any operational problems.

Type ? <CR> to see list of commands

.....

SPRINTLINK: type in telnet services.desse.state.mo.us

Trying...

telnet: connect to address: 128.206.20.119

Figure 8 - Sprintlink Screen

7. Type in your services.desse.state.mo.us "userid"
8. Type in your services.desse.state.mo.us "password"
9. You will receive a "Welcome" screen from Missouri DESE.
10. Touch the retm/enter Key and you will be at the main menu (see Figure 8).

<<< Main Menu >>>

1. About the DESE Technology Network Research Project
2. Electronic Mail
3. Community Information
4. Educational Projects (MORE-Tec...)
5. DESE Information
6. Resources
7. Manage your Files
8. Manage your Environment
9. Help

p = Previous Menu x = Exit System "go help" = extended help

m = Main Menu h = Help

Your Choice ==> 7

Figure 8 - DESE Main Menu



11. Select 7 Manage your Files. The system will then display the following screen.

```
<<< Manage your Files >>>

1. Using Files on MOREnet Services
2. Disk Use Policy
3. Check your Disk Space Usage
4. Help with file transfers
5. Send a file from your work directory to your PC
6. Send a file from your PC to your work directory
7. Check for files sent to you by other users
8. Retrieve files sent to you by other users
9. Send a file to another user
10. Manipulate files in your work directory
11. Open FTP

-----
p = Previous Menu  x = Exit System  "go help" = extended help
m = Main Menu    h = Help

Your Choice ==>
```

Figure 9 - Manage Your Files

12. To retrieve a file from MORE-Tech, select 5 Send a file from your work directory to your PC. You will then be greeted with the following screen.

```
SEND FILE(S) FROM FreePort TO YOUR PC

Select a file transfer protocol:

1. KERMIT
2. XMODEM
3. YMODEM
4. ZMODEM

----- OR -----

5. List files in work directory

-----
p = Previous Menu  x = Exit System  "go help" = extended help
m = Main Menu    h = Help

Your Choice ==> 1
```

Figure 10 - Download Screen

13. Select your preference for file transfer. In this example memo.mjd is used.

```
FILE TRANSFER USING KERMIT
Please enter file(s) to transfer: memo.mjd
Escape back to your local Kermit and give a RECEIVE command...
```



Integrated Activity Idea

Use gopher to locate information for a research paper for a class in school.



Technology Idea

Experiment with uploading and downloading text files, graphics, and applications programs. Send them back and forth to a friend to verify that your process is working correctly.



Technology Idea

Connect two PCs together through one of the communications ports. Write a simple program which will enable the two computers to communicate with one another (see TAM 12 in the Introduction to Communications Technology TAM for additional information).

14. Press ALT X or Control] to return to the MS-Kermit prompt. Enter RECEIVE and press [ENTER].

Kermit will display a screen indicating the download status. When it has completed the transfer, you will be returned to the MS-Kermit prompt. Press C and enter to return to MORE-Tech.

SEND FILE(S) FROM FreePort TO YOUR PC

Select a file transfer protocol:

- 1 KERMIT
- 2 XMODEM
- 3 YMODEM
- 4 ZMODEM

_____ OR _____

5 List files in work directory

p = Previous Menu x = Exit System

m = Main Menu h = Help

Your Choice ==> p

Figure 11 - Download Screen

15. Select 'p' to return to the previous menu.

Sending Files to MORE-Tech

To send a file to MORE-Tech, you should follow the same steps to get to the "Manage your Files" menu. At this menu select 6, Send a file from your PC to your work directory.

<<< Manage your Files >>>

1. Using Files on MOREnet Services
2. Disk Use Policy
3. Check your Disk Space Usage
4. Help with file transfers
5. Send a file from your work directory to your PC
6. Send a file from your PC to your work directory
7. Check for files sent to you by other users
8. Retrieve files sent to you by other users
9. Send a file to another user
10. Manipulate files in your work directory
11. Open FTP

p = Previous Menu x = Exit System "go help" = extended help
m = Main Menu h = Help

Your Choice ==> 6

Figure 12 - Manage Your Files



Integrated Activity Idea

Discuss the ways in which the computer is altering the ways in which people communicate with one another. Include in your discussion aspects such as impersonality, security, lack of body language & facial expression in communication, etc. In what ways has computer communication enhanced interpersonal communications? How has it restricted it? Can these restrictions be overcome? How?



1. You will see the following screen.

```
SEND FILE(S) FROM YOUR PC TO FreePort

Select a file transfer protocol:

1. KERMIT
2. XMODEM
3. YMODEM
4. ZMODEM

_____ OR _____

5. List files in work directory
_____

p = Previous Menu  x = Exit System  "go help" = extended help
m = Main Menu    h = Help

Your Choice ==> 1
```

Figure 13 - Upload Screen

Escape back to your local Kermit and give a SEND command.

7. Press ALT X or Control] to return to the MS-Kermit prompt. Enter SEND and press [ENTER]. Note: filename.ext is any file you wish to send to MORETECH.

Kermit will display a screen indicating the upload status. When it has completed the transfer, you will be returned to the MS-Kermit prompt. Press C and ENTER to return to MORE-Tech.

8. Press P and [ENTER] to return to previous screen. You have now successfully uploaded/downloaded a file to MOR

Note: Software handshaking involves the use of the communication program using a character XON (ASCII ^Q) as a signal to send information and XOFF (ASCII ^S) as a signal to stop sending information.

Materials Needed

Supplies

RS232C Cable

2/3 Switcher

communication software

(You may substitute any other computer instead of using MS/DOS PC's, however, you will need to obtain the proper communication software.)

Equipment

2 MS/DOS PC's

Procomm 2.X or other

For additional activities & for construction of a null modem cable, see TAM 12 of the Communication Technology Workshop Series.

Activity 4

Telephones

On March 10, 1876, Alexander Graham Bell invented the telephone. This was a result of experiments by devices to send multiple telegraph signals over a single line. Bell, a native of Scotland, made this fortunate discovery when he spilled acid on his pants. His reaction, the now famous "Mr. Watson, come here, I want you", brought Thomas A. Watson on the run. This was the first time sound was transferred over wires. This simple instrument was not practical since acid was used in the system, but Bell and Watson improved the design rapidly. Bell's invention was successful. By 1907 the Waldorf Astoria in New York City contained 1,120 phones and handled 500,000 phone calls a year.

In this activity, you will be using two telephones to construct a local telephone system.

Procedure

1. Construct the following wiring harness using one end from a telephone cord. Connect a battery to the lead as shown in Figure 14.

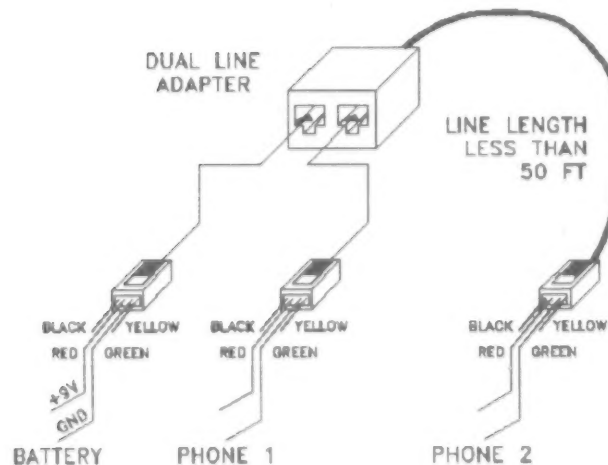


Figure 14 - Wiring Harness



2. Connect the wiring harness to the two phones as shown in Figure 15.

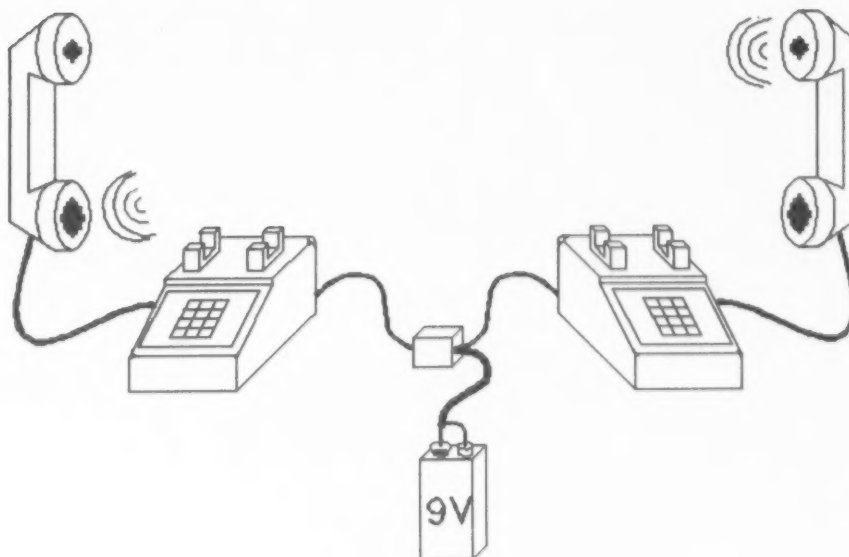


Figure 15 - Phone Connection

3. Have someone on each phone and have them pick up the phone and talk.

Discussion

In your phone system at home, the Central office provides the means to ring the other phone. This configuration does not provide a means to ring the other line. So you will have to be innovative in getting the other person to pick up the line. In the past, a hand crank was provided to the caller, who cranked the generator to induce a ring at the operators console who then would connect you to your party.

Materials Needed

Supplies

3 ft telephone cord
50 ft. telephone cord
Battery cable
Dual line adapter
(available most anywhere)

Equipment

2 telephones

Assessment

Scoring Rubric for Activity 2 - Peer to Peer Communication

Performance Standard	Wgt %	Exemplary 2 pts.	Acceptable 1 pt.	Not Yet Acceptable 0 pts.	Sub Total
I. Creative Thinker					
Speculate the future of various areas of telecommunications and telephony, including digital, analog, and visual communications.	x.5	Student offers 3 future uses of peer to peer digital communications.	Student offers 1 future use of peer to peer digital communications.	Student offers no future uses of peer to peer digital communications.	2 x .5 = 1
II. Critical Thinker					
Identify and appraise the hazards involved in connecting telecommunications equipment together.	x.5	Student identifies and appraises all hazards (per lecture/text) involved in connecting equipment.	Student identifies without appraising all hazards (per lecture/text) involved in connecting equipment.	Student identifies and/or appraises less than all hazards involved in connecting equipment.	2 x .5 = 1
Differentiate between the various protocols (hardware and software) in communications.	x.5	Student attempts three different software protocols for Activity 2.	Student attempts two different software protocols for Activity 2.	Student does not attempt any additional software protocols.	2 x .5 = 1
III. Contributing Citizen					
Comprehend how telecommunications impact and affect society and the everyday lives of its citizens.	x.5	Student lists 3 different ways Digital peer to peer communication have been used in society.	Student lists one way digital peer to peer communications have been used in society.	Student does not list any ways digital peer to peer communication has been used in society.	2 x .5 = 1
Recognize and analyze the potential positive and negative impacts of telecommunications.	x.5	Student lists 3 positive and 3 negative impacts of digital peer to peer communications.	Student lists 1 positive and 1 negative impact of digital peer to peer communications.	Student does not list any impacts of digital peer to peer communications.	2 x .5 = 1
IV. Self-Directed Learner					
Explain, illustrate, and demonstrate how a complete communication setup operates.	x.5	Student correctly explained, illustrated and demonstrated how a peer to peer system works.	Student explained and illustrated how a peer to peer communication system works.	Student could not explain, illustrate, or demonstrate how a peer to peer system works.	2 x .5 = 1
V. Problem Solver					
Solve problems related to a telecommunications project.	x1	Student solved all problems with no interaction from teacher.	Student solved problems with less than 3 interactions with teacher.	Student required constant supervision by teacher to solve problems.	2 x 1 = 2
VI. Effective Communicator					
Apply basic electrical/electronic terminology as it pertains to telecommunications and telephones.	x.5	Student correctly uses electronic terminology in peer to peer communications activities.	Student correctly uses terminology in communications activities 70% of the time.	Student uses inconsistent terminology in peer to peer communications activities.	2 x .5 = 1
Communicate orally, visually, and/or in writing the principles of telecommunications.	x2	Student effectively and correctly communicates all principles.	Student effectively and correctly communicated all principles 70% of time.	Student does not consistently communicate all principles.	2 x 2 = 4
VII. Quality Producer					
Demonstrate the safe use of equipment, supplies, materials, and processes that are related to telecommunications and telephone instrumentation.	x1	Student demonstrates safe use of all equipment, etc. at all times.	Student demonstrates safe use of equipment, etc. with teacher/ facilitator supervision.	Student does not demonstrate safe use of equipment at all times.	2 x 1 = 2
Comprehend communications cable technology by constructing a serial (RS-232) null modem cable.	x2	Correctly constructs an RS-232 null modem cable and uses it for peer to peer communication.	Student constructs an RS-232 null modem cable but fails to use for actual communication link.	Student does not correctly complete an RS-232 null modem cable.	2 x 2 = 4
VIII. Technical Foundations					
Identify the various foundation skills of telecommuting and how they are used by society.	x.5	Student correctly identifies three various foundation telecommunication skills.	Student correctly identifies one various foundation telecommunication skill.	Student does not correctly identify any foundation telecommunication skills.	2 x .5 = 1

Total: 20 out of 20 Possible



Activity 1 Worksheet

1. Compute the length of an half-wavelength antenna that would receive signals equally well on both ends of the FM frequency band. The FM range is from 88 to 108 Mhz. Please show your work.

2. Draw the resulting half-wave antenna below. Indicate the lengths.

(To convert meters to inches multiply by 39.3701 or 1 meter=39.3701 inches)

Pre-Test

Directions: Answer the following questions.

1. What is a radio wave? _____

2. How do radio waves move through space? _____

3. What's the purpose of an antenna? _____

4. How do computers transfer data? _____

5. How can two or more people exchange information using computers? _____

6. What is a computer BBS? _____

7. Why are BBS's important? _____

8. How does a telephone work? _____

9. List an important event in the history of telephones. _____

Check List

Directions: Evaluate the candidate by checking the appropriate letter to indicate the degree of competency.

Rating Scale: *Mastered* - has performed task satisfactorily.
Not Mastered - has not performed the task satisfactorily.
Not Applicable - skill not necessary for this system.

Not Not
Mastered Mastered Applicable

- Identify and practice shop safety.
- Identify and practice safe work habits.
- Demonstrate safe and proper use of hand tools.
- Demonstrate proper use of communication skills
- Fabrication of a FM antenna
- Demonstrate proper connection of a null modem cable
- Demonstrate safe and proper use of hand tools.
- Successful completion of a logon session with a BBS
- Successful completion of a file upload to a BBS.
- Successful completion of a file download to a BBS.
- Fabrication of a telephone station
- Demonstrate safe and proper use of AC line equipment.
- Wears Safety Glasses.



Performance Assessment - An Internet Scavenger Hunt

The Internet system offers access to an amazing variety of resources, information, graphics, and contacts. This assessment is designed to see how many kinds of "things" you are capable of locating. Good luck and happy hunting. Warning! Don't start this exercise until you have lots of time to spare. Once you get started, it's hard to stop!

Item to be found	Located	Where found-Path-Internet Address
Virtual reality information	☐	_____
Information about future space shuttle missions	☐	_____
Current weather report for Northern Alaska	☐	_____
A graphic of a 1955 Corvette	☐	_____
Review of a current movie	☐	_____
A clean joke	☐	_____
Information on old cars	☐	_____
National Science Foundation information	☐	_____
A Windows program	☐	_____
News about Power PC native software .	☐	_____
A shareware CAD program	☐	_____
Information about smart house technology	☐	_____
An article from a Russian newspaper	☐	_____
A good cookie recipe	☐	_____
Information on robots	☐	_____
Lyrics for Arlo Guthrie's "Alice's Restaurant"	☐	_____
TOTAL Number Located ☐		

Remember: It is very important to document the route you used to access the information because you will likely need to access it again sometime. Also, technical documentation is one of the important key skills in all technologically oriented activity.



By Lynn Diel

Instructor Resource

Technology On Line

Content Outline

1. FM Communications

- Used for reliable transfer of information over radio waves
- Requires small size for use in telecommunications due to its higher frequencies.

2. Peer - to - Peer Communications

- Terminology: Terms and definitions
- Discussion of the hardware components
- Discussion of the software components

3. File Uploading/Downloading

- Discussion of the various communication protocols.
- Discussion of the various methods for transferring of information (Hand-shaking)
- Discussion of ethics and behavior for accessing BBS systems and information.

4. Telephony

- History of the telephone
- Discussion of telephone switching systems and concepts
- Important advances in telephones.
- Discussion of Cellular phone technology
- Discussion of telephone features and how they affect telecommunications (call waiting, etc.)

Instructional Resources

Books

- Fike, J. L., Friend, G. E. (1983) Understanding Telephone Circuits. Dallas, Tex. : Texas Instruments ; Indianapolis, IN: Howard W. Sams (An excellent resource for understanding basic telephone structures . Contains many anecdotes about the history of telephones.)
- Friend, G. E. et.al. (1984). Understanding Data Communications. Dallas, Tex. : Texas Instruments ; Indianapolis, IN: Howard W. Sams & Co. (Provides a solid foundation on the understanding of data communications.)
- Seyer, M. (1984), RS-232 Made Easy. Englewood Cliffs, N.J.: Prentice Hall. (Tells how to connect computers and peripherals together.)

Software

- PROCOMM 2.4.3 (communications program) Program: Shareware (MS-DOS) Available on MORE-Tech In the Resource Room
- KERMIT - (communication program) Program: Freeware (MS-DOS, MAC, Apple II); Available on MORE-Tech In the Resource Room
- Etiquette for telecommunications. Document: A document on the proper behavior for using telecommunications. Available on MORE-Tech In the Resource Room
- Cruising the Internet. Program: Freeware. An excellent windows based program with graphics on how to access the Internet. Available on MORE-Tech In the Resource Room.
- MODEM Doctor Program, Program: Shareware. An excellent program for diagnosing modem connection problems. Available on MORE-Tech In the Resource Room
- The Zen of Internet. Document: A condensed version of the book, Excellent reference material on accessing information systems.



Glossary of Terms

ASCII - American Standard for Communication Information Interchange.

Baud Rate - The number of times per second that a communications channel makes a change in state.

BBS - Acronym for Bulletin Board System.

Bits - A bit is the least significant digital signal. It can contain a value of either 0 or 1.

BPS - Bits Per Second. The number of data bits that are transmitted per second.

Byte - A group of eight bits. One byte contains enough information to describe one character.

CCITT - The initials for International Telegraph and Telephone Consultative Committee

CPS - Characters Per Second. The number of complete characters transmitted per second.

DCE - Data Communications Equipment

Download - The process of copying a file, through a transmission line, from the remote system to your system.

DTE - Data Terminal Equipment

Freeware - Software that is made available to the public and is free to use. The author of the program expects no payment for his/her product.

FMM - Frequency Modulation, where the frequency of the signal is varied but the amplitude is steady.

Handshaking - A method of communication between two devices.

Hardware - Uses a digital signal.

Software - Sends a special character for start/stop.

Log off - The process of entering the information necessary for normal exit from a BBS or network system.

Log on - The process of entering the information necessary to gain entry into a BBS or network system.

Modem - A device used for converting digital computer signals to analog phone signals. **MOdulator/DEModulator**.

Netiquette - A combined word meaning **NETwork etIQUETTE**. The proper and polite use of network systems and resources.

Noise - Unwanted signals that are introduced onto a phone line.

Null Modem - A device that connects two DTE devices directly, by emulating the physical connections of a DCE device.

Parity - A scheme for verifying the contents of a transmitted data byte.

Protocol - A standardized system of codes or signals.

RS232 - Recommended Standard 232 by Electronic Industries Association (EIA).

Shareware - Software that is available to the public with limited review privileges. The author expects payment if the program is used beyond the preview period.

SYSOP - Acronym for the **SYStem OPerator** of a BBS. The person responsible for managing the files and resources of the BBS.

Upload - The process of copying a file, through a transmission line, from your system to the remote system.

Safety Factors

- The construction of the FM antenna requires the use of a soldering pencil (20-30 watts).
- During the construction phases of the activities the student should wear safety glasses.
- Follow all safety rules regarding the use of the hot glue gun.
- Follow all operating instructions when using the computer and peripherals.

Instructional Suggestions

Motivation

- Guest speaker on telephony
- Tour a telephone switching network
- Have a guest speaker from the Cellular industry
- Have a radio engineer as a guest speaker
- Log onto a BBS and download a game
- Download the weather map graphic for your location
- Establish a computer pen-pal in another country
- Send an e-mail message to the President, Vice-President of the United States, or to a national news organization

Prerequisite Information

- Familiarity with computers

Demonstrations

- Log onto a BBS system
- Download a file pertinent to this TAM from MORETECH
- Access and do a book search at a remote library using the Internet.
- Have a representative from the Cellular industry demonstrate how to access a BBS via a Cellular phone.

Academic Enrichment

- Arrange for interested students to work part-time at a local TV, video or communications center.
- Have students construct a simple Morris code sender/receiver.
- Visit a telephone switching station.
- Discuss with other students how you might create your own Private Branch Exchange (PBX).



Academic Enrichment

- Provide students with the handouts about computer usage.
- Provide students with handouts about telephone systems.
- Students should perform Information prospecting (research) using the Internet.

Related TAMS

- Introduction to Communication Technology Guide
 - TAM 2 Using ASCII for Telecommunications
 - TAM 7 On-Line Computer Communications
 - TAM 9 Fiber Optics
 - TAM 10 Intercom Systems
 - TAM 11 Home Security Monitoring System
 - TAM 12 FM Transmitter
 - TAM 13 Building an AM Radio
 - TAM 14 Video Synchroclases
 - TAM 17 Animation
- 1990 Implementation Workshop TAMS
 - TAM 2 Fiber Optics
 - TAM 12 Communicating via Computer and Faxes
 - TAM 16 Introduction to ITE/Modem Satellite Communication
 - TAM 19 The Information Age
- 1991 Implementation Workshop TAMS
 - TAM 2 Computer Job Printing/Image Scanning
 - TAM 12 Communication Via Computer and Fax
 - TAM 18 Fiber Optic Communications: Transmitter

Assessment/Evaluation Suggestions

- Develop a list of criterion which will be used by the instructor or students in determining the assessment of the products in this TAM. For example, criteria for the FM antenna could be the quality of construction, the neatness of the splices, the neatness of the splices, etc.
- Use the developed criteria check off sheet.
- Have the students download their homework assignments from a BBS
- Have the students turn in their homework electronically.

Note: Review the assessment items which are presented throughout the Performance Standards TAMS for ideas which can be adapted for this TAM. You should also refer to the Performance Standards Implementation Handbook for additional assessment examples and ideas.

Summary

In this TAM the students will have constructed a FM antenna, performed Peer-to-Peer communications, logged onto a BBS, uploaded and downloaded files, and constructed his/her own phone system. These activities are not all inclusive but should provide the student with a fundamental understanding of the nature of telecommunications and telephony. For these are the technologies of the future.



Worth 10,000 Words

Goal

The goal of this TAM is to provide a basic introduction to and hands-on experience with some basic procedures used to communicate through the use of graphics.



Mathematics



Communications



Science



Social Studies



Fine Arts



Health



Technology

Performance Standards

- Know the basic graphic communication technology terms including names of equipment, materials, and processes used in the classroom and laboratory;
- Compare and contrast the effectiveness of various communication methods, including graphic (visual) and verbal communications;
- Discuss how the use of computer technology has changed graphic communications processes in the areas of photography, screen printing, CAD, desktop publishing, and other graphic technology processes;
- Demonstrate care of sensitive and fragile equipment when using any graphic communications laboratory materials and equipment;
- List and describe the various applications of graphic communication technology, including everyday, specialized, and future uses;
- Identify the various foundation skills for different career options in graphic communications;
- Comprehend how graphic communication technology impacts and affects society and the everyday lives of its citizens;
- Perform basic operations with graphic communication technologies in areas such as photography, CAD, screen printing, and desktop publishing.



Introduction

Graphic communications are so prevalent in our culture that we often take them for granted. Words are often insufficient to express ideas, sometimes because of the complexity of the idea; more often because of the simplicity of an idea. Drawing, painting, photography, printmaking—all the illustrative graphic arts are a means of sharing ideas and vision. This TAM presents 2 activities on specialized photography and 2 on graphic arts, 1 on screen printing and 1 on desktop publishing.

Photography is used for chronicling the events in our lives, advertising products, and the promotion of organizations. But it also has many uses in technology:

- for the acquisition of data,
- to make images of things that cannot be seen with the unaided eye,
- to provide a permanent record that can be shared with others.

Screen printing is a form of graphic communications used to reproduce designs and images. The process is used to print on glass, metal, fabric, plastics, and paper. Screen printing is certainly not new but is still used extensively. Screen printing on T-shirts is one of the "hottest" trends in screen printing. In this TAM you will design and print a T-shirt design of your own.

Desktop publishing uses micro-computers to create printed materials. Anyone with a computer, printer and software can create interesting printed materials in a matter of minutes. You can do what used to take years of experience and lots of equipment. Desktop publishing is widely used not only by computer owners but throughout the printing industry.

Objective Statement

The activities described in the following pages represent samples of activities which can be used to deliver the performance standards on page 1. Many additional activities can and should be used. Extreme care should be taken to connect each activity with appropriate activity objectives as well as with the above performance standards. These objectives should be developed by the instructor and should be shared with and made clear to the students.



Integrated Activity Idea

Check with the science instructor to see if it makes a difference if the photograph were taken in the winter or the summer. How can you find the answer to this question?



Technology Idea

Arrange for a visit with a professional photographer to explore possible career options. What kinds of skills and education are required for photography related careers?



Integrated Activity Idea

Compare actual measurements of an object with measurements from a photograph of the same object. Are the measurements proportional? What is the percent difference?

Activity 1

Photography as a Tool of Measurement

Photography has many applications as a tool for the measurement of time and changes in distance over time. This TAM will use astrophotography to measure the rotation of the earth.

From our perspective, the stars don't stand still. They move through the night sky because of the rotation of the earth. A time exposure of the stars records their images as traces on the picture. You can use your recorded time of exposure and measurement of the angle of the traces to calculate the amount of the earth's rotation.

You can use the tracing of star trails included with this TAM (Fig. 1), or make your own photographs using the following technique.

Astrophotography technique: Astrophotography can be done with a minimum of photographic equipment and no knowledge of astronomy. The only requirements are a camera that's capable of time exposures (the shutter will usually have a setting marked B just below the 1 second exposure setting), a sturdy support for the camera like a tripod, and a cable release that can be locked to hold the shutter open. The cable release serves to isolate the camera from any vibrations that would be introduced by holding your hand on the camera during the long exposures necessary for astrophotography.



Figure 1 - Star Trails



Procedure

1. Load your camera with a 400 ISO color or black and white film. Any lens focal length you have is suitable for photographing star trails. Because even the closest stars are so mind-bogglingly far away, the focal length of the lens will not affect the size of the star's image on the film. Set the lens focus on infinity (if we ever had a subject at infinity, this one truly is). Set the lens aperture to its maximum opening (for example $f1.4$, 2, 2.8, or 3.5). Make the photographs on a moonless night in order to get the darkest sky possible in the photograph.
2. In order to measure the angle of the star trace you'll need to have the axis in the photograph. The axis for the rotation is the point that the earth's axis points at. The North star Polaris is very close to that point of rotation. In order to find the North star, look for the Big Dipper constellation. The two pointer stars in the Big Dipper connect an imaginary line with the North Star in the handle of the Little Dipper. Be sure to have the North star somewhere in the viewfinder of the camera (See Fig. 2).

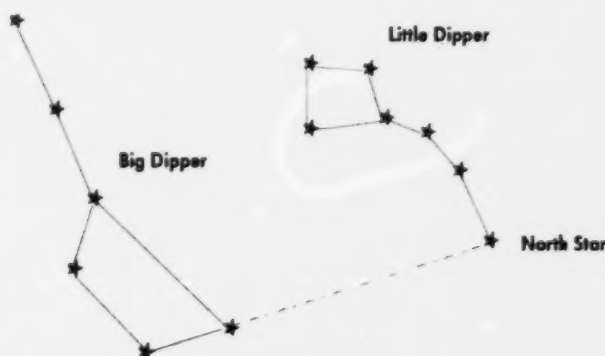


Figure 2 - Constellations

3. Make a series of exposures starting with 2 minutes and doubling it for each succeeding exposure. Make the following exposures: 2 minutes, 4 minutes, 8 minutes, 16 minutes, 30 minutes, 1 hour, and 2 hours.

Exposure time in excess of 8 minutes will require a location away from city lights. The reflections of street lights off of dust and moisture in the air will expose the background of your photograph during exposures in excess of 8 minutes.

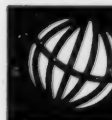
After some time in the dark your eyes will become dark adapted and you will be able to see the stars with unusual clarity. To preserve the dark adaptation, use a red filter over the bulb of the flashlight. The best inexpensive source for a flashlight filter is a red acetate report cover.

If the humidity is high, you may have a problem with dew forming on the lens surface. Periodically use the flashlight to check the surface of the lens.



Integrated Activity Idea

Calculate the rotation of earth for your various exposures.



Integrated Activity Idea

Do a historical study of instruments which have been used in attempts to measure and understand the stars.



Integrated Activity Idea

Prepare an astronomy report using output from a computer spreadsheet.

If possible, warm the camera so that its temperature is slightly higher than the air temperature. Otherwise, use lens tissue to wipe the lens surface dry between exposures.

4. After the photographs have been developed, you're ready to measure the earth's rotation.

Place a sheet of clear acetate over the photograph. Using a straight-edge and a suitable marker, draw two lines from the axis of the star trails to the starting and ending edge of any star trail. Since the North star is slightly off the axis of the Earth's rotation, the axis of the trails will be inside the arc described by the North star. Use the protractor to measure the angle of the 2 lines.



Figure 3 - End Point Angle

In this example, (Fig. 3) the angle formed by the end points of the trail is 89° and the exposure time was 6 hours. The calculated rotation of the earth is 14.83 degrees per hour.

The calculations are easily done with pencil and paper or the numbers can be used to develop an exercise in building a spreadsheet. Theoretically, if the earth makes a complete rotation in 24 hours, then the rotation per hour should be 15° —students can use their measurements and calculations to determine if it is so.

	A	B	C	D	E
1	Exposure	Measured	Earth's	Earth's	Avg. of the
2	time in	angle in	rotation	rotation	calculated
3	minutes	degrees	degrees per	degrees per	degrees per
			minute	hour	hour
4	1440	360	0.25	15.00	14.87
5	360	89	0.25	14.83	
6	120	29	0.24	14.50	
7	60	60	0.25	15.00	
8	30	8	0.27	16.00	
9	15	3.5	0.23	14.00	

Figure 4 - Spreadsheet



Integrated Activity Idea

There are many astronomical subjects that can be photographed without the use of a telescope. You should discuss these possibilities with the science instructor. If possible, you could also visit an observatory at a university or at a science lab.



The spreadsheet below shows the formulas for the preceding chart.

	A	B	C	D	E
1	Exposure time in minutes	Measured angle in degrees	Earth's rotation degrees per minute	Earth's rotation degrees per hour	Avg. of the calculated degrees per hour
2					
3					
4	1440	360	=B4/A4	=(B4/A4)*60	=Average(D5..D9)
5	360	89	=B5/A5	=(B5/A5)*60	
6	120	29	=B6/A6	=(B6/A6)*60	
7	60	60	=B7/A7	=(B7/A7)*60	
8	30	8	=B8/A8	=(B8/A8)*60	
9	15	3.5	=B9/A9	=(B9/A9)*60	



Integrated Activity Idea

Look for information about the various wavelengths. Which one can be seen with the naked eye? How have these wavelengths been used in technological devices (such as lasers, microwaves, etc.)?

Figure 5 - Spreadsheet Formulas

The spreadsheet presents the information in a clear, direct manner. From the example above it's easy to see that measurements taken from several photographs may not give exactly the same results. A graph may give some perspective on the results.

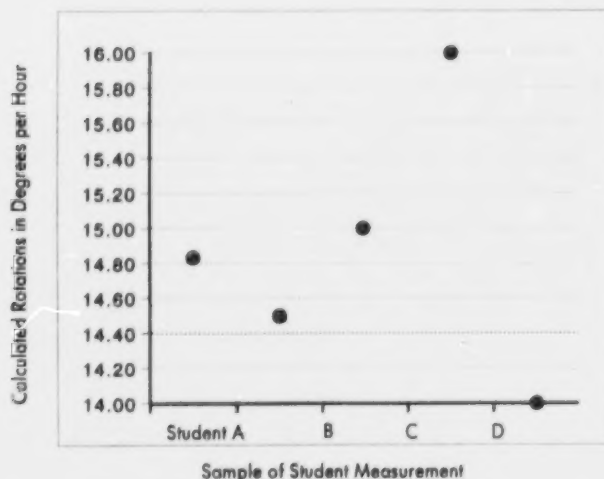


Figure 6 - Chart

Focus Questions

1. What are the high and low measurements?
2. Do the measurements tend to cluster around the predicted rotation of 15°/hr?
3. If we collected more data would the results be more accurate?

Materials Needed

A 35 mm camera, capable of time exposures.
A tripod or other steady camera support
Cable release or other method of locking the shutter open.
Film (ISO 400 preferred)
A penlight with a red filter
Lens tissue
Protractor
Computer with spreadsheet program



Activity 2

Photography as an Extension of Vision

Photography is used in many ways to extend the range of human vision. Photographs can be made using wavelengths of the spectrum that are beyond human perception such as ultraviolet and infrared. Photographs can be made of objects too small or too far away to be seen with the naked eye. Many events occur in a time frame that is too long or too short for human perception. Time exposures can record those events that occur over a long period of time. Stop-motion photography can be used to record those that happen too fast for unaided perception.

Shutter speeds in some 35 mm cameras are so fast that they can capture an exposure at times of $1/8000$ of a second. This can stop very fast motion. The problem is to synchronize the triggering of the shutter with the action being recorded. If you were to wait until you saw or heard the activity take place and then pressed the shutter release, there would be too great a delay between the action and the moment of exposure. The customary method of capturing stop motion images uses some sort of synchronizing device that triggers an electronic flash while the shutter in the camera is open.

Electronic flash commonly offers a burst of light with a duration of $1/1000$ or less. Auto-exposure flashes that use an electronic sensor to determine the proper amount of light for an exposure can deliver flash durations as short as $1/25,000$ of a second. Any type of electronic flash can be used to demonstrate the motion stopping ability of photography.

An electronic synchronizing device must be a solid-state device (mechanical relays produce a delay) that uses sound waves or an interrupted light beam to determine the instant of exposure. These electronic trigger devices have very limited application and tend to be very expensive.

Proceeding on the principle that it is inefficient to do with more what can be done with less, this TAM describes 3 low cost methods for synchronizing an electronic flash with the activity to be recorded on film.

The same general procedure is used for all three flash trigger methods. The room used to make stop-motion photographs needs to be able to be darkened. The technique does not require a completely dark room. Depending on the power of the flash used, the aperture of the camera will be such that a low level of ambient light will not affect the exposure. You will need to have some light in the room to be able to see what you are doing.

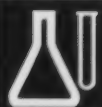
Stop-motion photography can be done with most cameras. Even most Polaroid cameras have a long enough shutter speed setting to work. You will need a tripod or some other support to hold the camera.

The use of safety goggles is recommended if you are going to photograph something that will have flying particles such as photographing a light bulb being broken by a hammer. A clear UV filter can be used over the camera lens to protect it from flying particles.



Integrated Activity Idea

Take a photograph of yourself - be creative! How can photography be used as a form of self expression?



Integrated Activity Idea

Invite an agronomist to speak to the class about the use of infrared photography as an aid to vision in the field of agriculture. Explore career options including training and education needed.



Integrated Activity Idea

Photographs can have create a strong emotional response in people who view them. Write a paper about the effects such photographs have had on various cultures. (Ex. war photography, satellite photographs, photojournalism.)



Technology Idea

Invite a photographer from a law enforcement agency to speak to the class about the use of photography to preserve impermanent evidence such as footprints or to document items too large to bring into a courtroom.



Integrated Activity Idea

Have the students collect photographs from magazines that show images that extend the range of human vision. Some examples might include photographs made with a microscope or telescope, x-rays, satellite photographs.



Technology Idea

Use the Photoshop software program to manipulate a digitized photographic image.

Procedure

1. To make the photograph, set up the subject using one of the trigger methods described later to synchronize the activity with the flash.
2. Connect the cable from the flash to the contacts on the trigger.
3. Set the camera on the tripod or other support and focus the lens on the area where the activity will take place.
4. Set the shutter on the camera to the B or T setting. A locking cable release is not necessary but would be an aid if you don't have someone to hold the shutter release down.

If you have an automatic flash, set the ISO of the film on the calculator dial of the flash. The dial will indicate the correct aperture to set the *f*stop on the lens. With an automatic flash, the light output is adjusted by the flash depending on the distance from the subject. The closer to the subject, the shorter the flash duration will be increasing motion stopping ability.

Manual flashes also have a calculator dial, but you will have to consult the calculator to determine the correct *f*stop for the distance from the subject. Remember it is the distance from the flash to the subject and not the distance from the camera to the subject that determines the exposure for flash photography.

The specific sequence for photography follows each of the trigger descriptions, but in general:

1. The object is placed in front of the camera
2. The camera is focused and exposure controls set
3. The room light is turned down
4. The camera shutter is opened
5. The event triggers the flash
6. The shutter is closed

Trip Thread Trigger

To make a trip thread trigger for the flash, wrap the edge of thin piece of metal around a nail to form a hinge. The other edge of the metal flag is notched to hold the knotted end of the thread. The two contact wires from the flash are wired to the two nails. The ability to shape the trigger area using screw eyes is the advantage of this method. Adjust the tension on the thread until the metal flag almost touches the second nail. By increasing or decreasing the amount of tension you can adjust the amount of delay in the moment of exposure. This trigger could be used to photograph the moment of collapse of a load test on a model bridge.

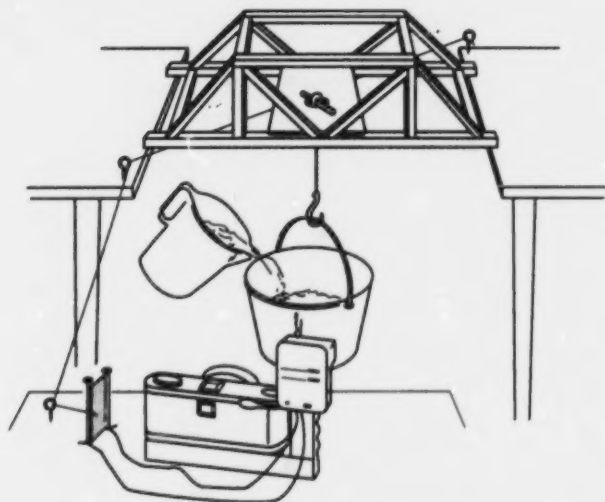


Figure 7 - Trip Thread Trigger

Spring Contact Trigger

The spring contact trigger is another of the various abuses the common paper clip must endure. This type of trigger is used to photograph the results of an impact on an object. You can capture the fracture lines in a light bulb that form just prior to an implosion or the graceful shapes and patterns that are created when ripe fruits are splattered.

To make the trigger, spread a paper clip open to an angle just less than 180° . One end of the clip is screwed to a board and a second screw is placed in the board just under the other end of the clip. The two contact wires from the flash are wired to the two screws.

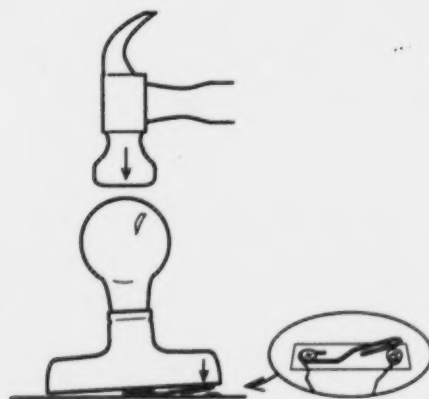


Figure 8 - Spring Contact Trigger

To take a photograph of a light bulb being shattered:

1. The object is placed in a holder or directly on top of the contact switch.
2. The room light is turned down.
3. The camera shutter is opened.
4. A hammer or other heavy implement is used to smash the bulb, triggering the flash.
5. The shutter is closed.
6. Clean up the mess, adjust the spring tension, and try another photograph.



Technology Idea

Have a roll of film developed onto a photo CD (available option through major photo processors, e.g. Kodak). Access your pictures using a computer which has a CD drive.

The amount of delay is controlled by adjusting the distance between the end of the paper clip and the screw contact to determine how far the hammer is through the object at the time of exposure. Bending the paper clip up higher will give a photograph that shows just the beginning of the action. Bending it lower will give a photograph further in the process.

The Acoustical Trigger

The acoustical trigger uses sound waves to trigger the flash. Because this is a mechanical trigger, it will only work well for loud sounds like the popping of a balloon.

To make the trigger, cover one end of an open cylinder like a piece of PVC drain pipe with a rubber membrane to form a diaphragm. Glue a small square of aluminum foil to the center of the diaphragm. Fasten the cylinder to a support and attach an angle bracket directly behind the diaphragm end. File the end of a bolt to a point and thread it through the bracket. Attach the flash contact wires to the aluminum foil and the bracket. You can adjust the amount of delay in the exposure by moving the trigger closer to or further away from the activity.

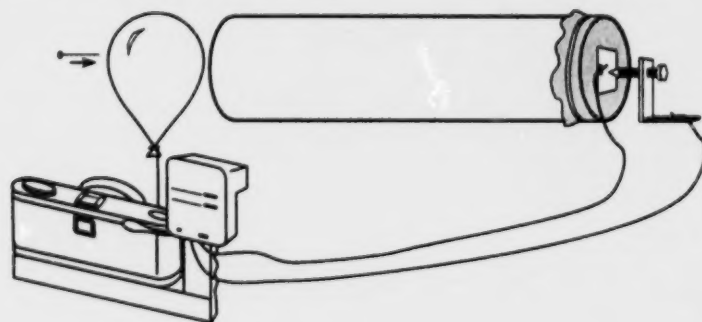
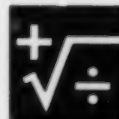


Figure 9 - Acoustical Trigger



To use the acoustic trigger:

1. Point the open end of the cylinder at the source of the sound.
2. Adjust the bolt so that it just breaks contact with the aluminum foil.
3. Have Instructor check setup. **Instructor's Initials**
4. Turn the room lights down.
5. Open the camera shutter.
6. Execute the action (for example, toss a dart at an inflated balloon).
7. Close the shutter.
8. Adjust the distance from the trigger to the action and try another photograph.



**Integrated
Activity Idea**

Suppose you change the distance of the trigger from the action from 6' to 3'. How much would that change the delay?

Materials Needed

35 mm or Polaroid camera

Film (100-400 ISO)

Flash synch cord that connects to the strobe that can be cut and wired to the synchronizing device.

Safety goggles

Materials for construction of the trigger device (described in each section)

Activity 3

Screen Printing

Screen printing is a fun and exciting form of graphic communications. You see screen printed items every day. Designs on T-shirts, jackets, bottles, cans, bumper stickers, and signs are just a few of the items printed using screen printing.

The process works by stretching a cloth screen material over a frame. This screen material allows inks or paints to pass through. A pattern adhered to the screen blocks the ink from passing through. Ink is allowed to pass through the screen in places where the design is wanted. This pattern can be paper, film, or an emulsion material. The screen and pattern are then placed in contact with the object to be printed. Ink is placed on the top side of the screen and pulled across the screen with a squeegee. The squeegee spreads the ink and forces it through the screen only where the pattern will let it through the screen. The screen and pattern are lifted from the object leaving the printing ink on the object.

In this activity you will be introduced to the screen printing process. You are to design and print a poster or T-shirt.



Integrated Activity Idea

Through the use of a special jig, you can screen print images on cylindrical objects like mugs, glasses, etc.

Limitations and Specifications

- Print will be one color
- Maximum design size 8" x 10"
- Stencil must be hand-cut from paper
- T-shirt must be supplied by student
- Should include one graphic
- Should include one line of text

Procedure

Making a Paper Pattern

Perhaps the most difficult part of the screen printing process is deciding what to print. Start by looking through your favorite magazines, comic books, coloring books, or clip art books. For a paper pattern you will want to keep your design simple. Take your time developing your design. Your design will be uniquely yours - it will be the only one exactly like it in the world. Have fun!



1. Start by drawing or tracing your design onto a piece of 8 1/2" x 11" paper. Avoid getting closer than 1" to the edges of the paper.
2. Shade in on the drawing where the ink will print through. If your design has complicated detail you will need to make "bridges" to hold the detail in place. "Bridges" or breaks, in the outline, are added to left side of the horse in Figure 9. Silhouettes, like the right side of the horse, can be printed without "bridges."

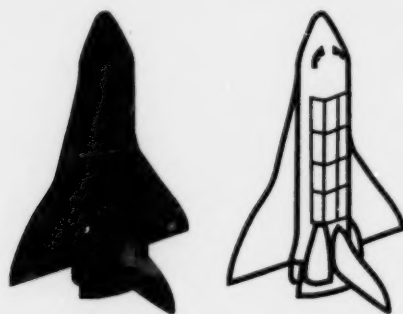


Figure 10 - Graphic Design

3. Tape your design to a cutting surface such as cardboard or a special cutting mat. Center a piece of freezer paper (9" x 12"), coated (shiny) side up, on top of your design and tape in place. (See Figure 10).

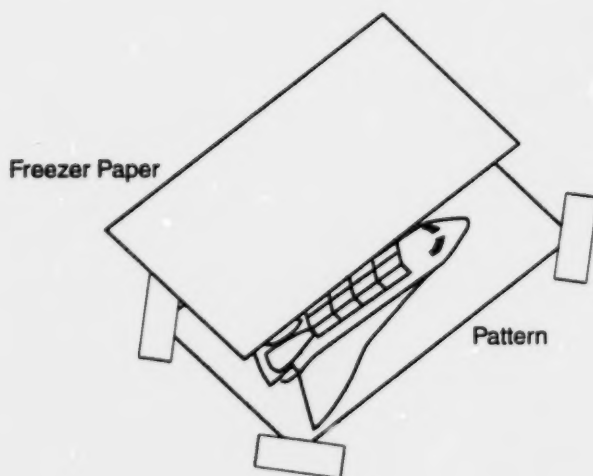


Figure 11 - Design Layout & Cutting

4. Cut through the freezer paper following your design with a craft knife. Remove all the shaded areas leaving everything else. (Note: If you have trouble seeing your design you may trace it to the freezer paper before cutting. A light table can be helpful.)



Technology Idea

Patterns can also be designed using computer programs such as *Typewriter*. Graphic images can also be obtained from clip art or even from photo CD.

Preparing the screen

The screen you will be using must be stretched on a 12" x 16" frame. Be careful not to damage the stretched screen. Be very careful when using sharp object around the screen. If you cut the screen it will need to be removed and a new screen stretched in place. The screen must be clean without any blockage from dried ink. Hold the screen up to the light to check for blockage.



Technology Idea

You might wish to use a photosensitive emulsion instead of the manual cutting method described in this activity. This is a little more expensive but will allow you to include much more fine detail.

1. Tape the inside corners of the screen, where the frame and screen meet, with 2 inch masking tape. Start at the top of the frame and continue down onto the screen. This helps keep ink out of the corners making cleanup easier. (See Figure 12)

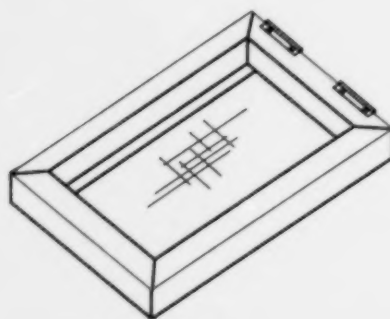


Figure 12 - Stretched Screen Setup

2. Mount the screen on a hinged printing frame. Center a piece of printing paper, under the screen, on the printing surface or "register board". Mark two places along one side and one above the paper. Attach three (3) guides made of masking tape at the locations just marked. (See Figure 13 - shown with screen removed for clarity.)

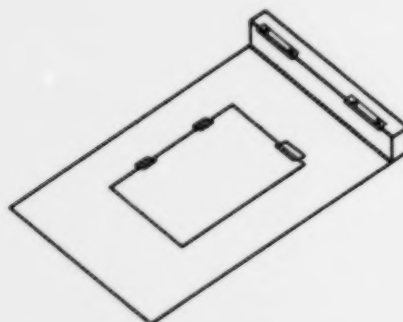
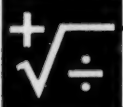


Figure 13 - Register Board

3. Leave or put a piece of paper in place against the paper guides. Center your pattern on the paper to be printed. Make sure that all pieces of the pattern are in place. NOTE: DO NOT PLACE ANY PART OF THE PATTERN UNDER THE PAPER GUIDES.



Integrated Activity Idea

Freezer paper comes in 150 square foot rolls which are 18 inches wide. Work with the mathematics instructor to determine how many 9 inch by 12 inch pieces could be cut from a roll of freezer paper.



4. Carefully lower the screen onto the pattern and printing paper. If necessary, add any masking to lap over your pattern by approximately 1/2 inch. **Instructor's Initials**

Getting Ready to Print

5. Prepare your materials to be printed at this time. You will be using a water based ink which will dry in the screen if printing stops for more than a moment. You will not have time to search for printing materials after you begin.

Note: If you are going to print a teeshirt get it ready at this time. If your printing frame allows teeshirt printing simply have your shirt ready to put in place. Otherwise place a large piece of heavy smooth cardboard inside your teeshirt. However, do not stretch the teeshirt.

6. Complete this pre-printing check list.
- ☐ Printing paper is ready (6 sheets)
 - ☐ T-shirt ready (see note above)
 - ☐ Cover table with newspaper
 - ☐ A putty knife is on hand
 - ☐ Have correct size squeegee
 - ☐ Have enough time to print and cleanup
 - ☐ Read and understand all the instructions below including the clean-up procedures.



Integrated Activity Idea

Examine the chemical content of water and solvent-based screen printing inks. What are the potential health and environmental hazards of the various chemicals?

Printing the Design

7. Select the appropriate printing ink (poster or textile). Apply the ink to the top of the screen and squeegee across the pattern then back. Use firm pressure and angle the squeegee slightly as you print. (See Figure 14)
- Note:** the pattern will stick to the screen and remain there while you print.

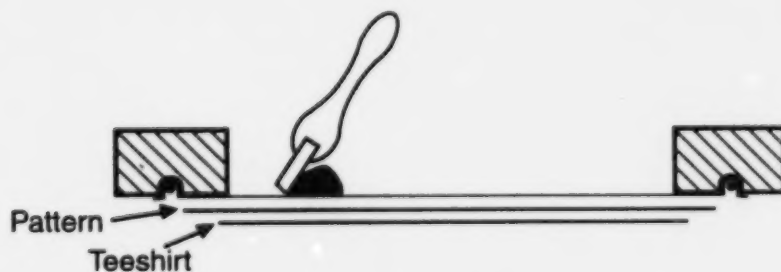


Figure 14 - Printing Process Illustration

8. Raise the screen and remove the print. If the print sticks to the screen gently pull it away. Be careful not to peel the pattern away from the screen.
9. Print your copies including one to turn in for evaluation. If you are printing a teeshirt put it in place and print it at this time. If using cardboard inside the shirt remove the screen from the printing frame and lay in place on the teeshirt then print.

Cleanup Procedure

10. Remove excess ink from the screen with a putty knife. Be careful not damage the screen. If the ink is not dried or contaminated return it to its original container. If unsure check with instructor.
11. Remove the paper pattern and masking tape from the screen and throw away.
12. Wash the squeegee, screen and other tools with soap and water. Note: It is very important that no ink be left in the screen to dry.
Have your instructor check your cleaned equipment.
13. Follow the ink manufacturer's recommendations for the curing or drying of the screen print ink used.
14. Turn in one copy of your design for evaluation.

Materials Needed

Freezer paper (coated) 9" x 12"
Craft knife
Stretched screen 12" x 16" with printing frame
Masking tape - 2 inch
Poster ink or textile ink (water based)
Squeegee sized to fit the screen
Six (6) sheets of paper for printing
T-shirt (supplied by student)
Putty knife



Activity 4

Desktop Publishing

Desktop publishing uses micro-computers to assemble page layouts without the use of common paste-up and production methods. Newsletters, brochures, and advertisements are jobs typically created on desktop publishing systems. Many small jobs can be successfully completed in a short time and with acceptable quality using your computer and printer. The final quality of the printed job will depend on your hardware and software capabilities. Laser printers can print near typeset quality. The color, size and quality of the stock you print on will also affect the job quality. In this activity you will use a computer to design and print a notepad.

Limitations and Specifications

1. Notepad should include one graphic.
2. Contain at least two lines of text.
3. Be approximately 4" x 5" in size.
4. Contain 40 pages.

Procedure

Designing Your Notepad

1. Bring in and examine notepads that you have at home and ones the instructor may have available. Notice what they have in common, how they differ, what you like, what you do not like, and which ones are unique.
2. Begin your notepad by roughing out your layout on a separate sheet of paper. Take some time to develop and refine your design. (See figure 14 on the next page for sample designs).
3. Once you think your design is ready show it to the instructor for approval. INSTRUCTOR'S INITIALS:

Using The Computer

4. Using an available computer prepare your graphics at this time. This may simply involve finding a graphics file stored on your computer. If a scanner is available you may want to scan an image into the computer. Either way save a copy of your graphic to your work disk.



Integrated Activity Idea

Define and find illustrations of the following from magazines and books:

- Balance
- Rhythm
- Contrast
- Other



Integrated Activity Idea

Design a newsletter for parents and other interested people focusing on the activities of a student club. Include some graphics. (Note: see 1991 Implementation Workshop TAM by Tom Reynolds.)



Integrated Activity Idea

Use DTP to prepare writing assignments for another class.



Figure 14 - Sample Notepad Designs



5. Following the start up procedures, demonstrated earlier by the instructor, load and run your desktop publishing software.
6. Load the file entitled "NOTEPAD". (This is a template formatted for notepads. It has four spaces provided for designing your notepad.)
7. Design and layout your notepad in the upper left hand space of the template. You may find it easier to paste your graphics in place first then type in the text. (Note: you will need to erase the instructions printed in the space first)
8. Copy the layout to the other spaces provided on the notepad template. Save your design using an appropriate name. Do not use the name "NOTEPAD"
9. Print a copy of the notepad. (Save this copy to turn in later for evaluation)
10. If the layout of the notepad is correct proceed to the next step; otherwise make necessary correction and repeat step 9 as necessary.
11. Erase all the layout marks such as those that indicate the corners of the each of the four notepads.
12. Print your design. You will need 10 copies for your notepad and one to turn in for evaluation. Your instructor will tell you how to get the needed copies. This may be by printing all copies on the printer or using a photocopier.

Making the Notepad

13. Cut the ten notepad sheets as previously demonstrated by the instructor.
14. Using the padding press or clamp as demonstrated by the instructor "pad" your notepad.
15. Once the padding adhesive has dried trim the edges of your notepad on the paper cutter. (Note: the paper cutter used for this activity must be able to shear up to 40 sheets at a time. If you do not have access to this type of paper cutter you can make a loose-leaf notepad or take your pad to a local print shop).
16. Prepare the following, in the order listed, to be turned in to the instructor for evaluation:
 - a. The completed notepad.
 - b. Copy of your design as printed in step 9 and 12.
 - c. Rough sketches of your design.

Materials Needed

Computer system

Word Processing or DTP Software

Printer

Padding adhesive (optional)

Paper cutter - flat sheet (optional)

Photocopier (optional)

Padding clamps (optional)



Integrated Activity Idea

Examine a wide selection of printed materials (magazines, advertisements, cartoons, newsletters, books, etc.) looking for printed layout ideas. Which kinds of layouts work? Which do not? Why?



Technology Idea

Develop one of the following using desktop publishing:

- an advertisement for a technology education class
- A technology education newsletter
- A super-looking resume
- A procedure sheet for an activity (such as screen printing, using a software package, etc.).

Assessment

Scoring Rubric for Activity 2 - Photography as an Extension of Vision

Outcome	Wgt %	Exemplary 2 pts	Acceptable 1 pt.	Not Yet Acceptable 0 pts.	Sub total
I. Creative Thinker					
Compare and contrast the effectiveness of various communication methods, including graphic (visual) and verbal communication.	x1	Student develops 3 new applications per each trigger.	Student develops 1 new application per each trigger.	Student doesn't develop any new applications.	
II. Critical Thinker					
Comprehend how graphic communication technologies impact and affect society and the everyday lives of its citizens.	x1	Develops 3 additional social uses (surveillance cams, crash dummies).	Develops 1 additional social use for triggers.	No additional social uses for triggers are developed.	
Know the basic graphic communication technology terms, including names of equipment, materials, and processes used in the classroom and laboratory.	x1	Student achieves 90% of a terminology exam.	Student achieves 70% of a terminology exam.	Student achieves less than 70% of a terminology exam.	
III. Contributing Citizen					
Demonstrate care of sensitive/fragile equipment and safety to oneself and others when using any graphic communications laboratory materials and equipment.	x1	Always careful with equipment. Always demonstrates correct safety practices.	Usually careful with equipment. Usually demonstrates correct safety practices.	Careless with equipment. Does not demonstrate correct safety practices.	
IV. Self-Directed Learner					
Identify the various foundation skills for different career options in graphic communications.	x1	Identifies 3 photography-related careers.	Identifies 1 photography-related careers.	No photographic-related careers are identified.	
V. Problem Solver					
Identify, compare, and contrast problems associated with more traditional graphic communication technologies (i.e., traditional drafting) and their newer technologies (i.e., CAD).	x2	Modifies and improves suggested trigger designs.	Suggested triggers are constructed and workable.	Suggested triggers are unworkable/unconstructed.	
VI. Effective Communicator					
Discuss how the use of computer technology has changed graphic communications processes in the areas of photography, screen printing, CAD, desktop publishing, electronic image manipulation, animation, multimedia, and other graphic technology processes.	x1	Names and describes 3 new computer-related graphic technologies.	Names and describes 1 new computer-related graphic technology.	Does not know any new computer-related graphic technologies.	
List and describe the various applications of graphic communication technology, including everyday, specialized, and future uses.	x1	Prepares error-free technical report of photographic technology.	Prepares well-written technical report (additional rubric/criterion sheet required).	Prepares error-free technical report of photographic technology.	
VII. Quality Producer					
Perform basic operations with graphic communication technologies in areas such as photography, screen printing, CAD, desktop publishing, electronic image manipulation, animation, multimedia, and other graphic technology processes.	x1	Triggers work consistently (90% of time) and show quality workmanship. Excellent photographic quality.	Triggers work 70% of the time. Appearance of triggers and photos are acceptable.	Triggers work less than 70% of the time. Appearance of triggers and photos are poor.	

Total: 20 out of 20 Possible



Short Answer Essay Questions

Photography as a Tool of Measurement Activity

1. If we collected more data, would the results be more accurate?

2. What factors would improve the precision of the measurements?

3. What If the photographic print were larger? _____
4. What If the protractor scale had more divisions? _____
5. Does the width of the tip on the pen used to mark the acetate affect the results? _____
6. Does the accuracy of the device used to time the exposure matter?

Photography as an Extension of Vision Activity

1. What kind of activity couldn't be photographed using the trip thread, spring, or acoustical trigger? _____
2. How would you design a trigger that would work for the above activity?

Check List

Product Assessment for Activity 3 - Screen Printing

Yes	No
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐
☐	☐

1. Design is original & creative
2. Design is tasteful & appropriate
3. The quality of and care taken in cutting the pattern was good
4. Procedures were followed
5. The image was appropriately registered
6. Proper squeegee handling techniques used
7. Printed image crisp and clear
8. Cleaned up work area



Instructor Resource

Worth 10000 Words

Content Outline

1. Time exposure photography

- Used for low light level photography
- Records events over a period of time
- Requires stable camera support
- Reciprocal exposure law departure
- Astrophotography
 - Moon
 - Planets
 - Stars

2. High Speed Photography

- Used to stop motion
- High speed cameras
- History of stop motion photography
- Applications in industry
 - Documentation
 - explosives
 - destructive testing
 - Engine timing
- Electronic flash triggers
- Exposure calculation
- Synchronization of event and recording

3. Screen Printing

- Screen printing materials & equipment
- How it works
- Screen printing stencils
 - Paper
 - Hand cut film
 - Indirect photo film
 - Direct photo emulsion

4. Desktop Publishing

- Applications
- Hardware & software
- Layout & design

Instructional Resources

Books

- Lovington, Michael. (1985). *Astrophotography for the Amateur*. Cambridge.
- Eastman Kodak Company. *Encyclopedia of Practical Photography*. "Astrophotography" p.140-158. Amphoto, 1977.
- Banzhaf, Robert A. (1983). *Screen Process Printing*. Mission Hill, CA: Glencoe Publishing Company.
- Dodt, Lorette C. (1990). *Graphic Arts Production*. Homewood, IL: American Technical Publisher, Inc.
- Fresener, Scott and Fresener, Pat. (1988). *How to Print T-shirts for Fun and Profit*. (rev. ed.). Phoenix, AZ: The Fresener Corp.

Magazines

- Voegelé, M. "On the road with photo-instrumentation." *Industrial Photography* 32, (#5). May, 1983. p. 23-25 (The use of high speed photography at the Ford Motor Company to evaluate visual information of events taking only a fraction of a second.)
- Tanenbaum, B. "Keeping the customer satisfied." *Photomethods* 30, (#7). July, 1987. p. 42-46. (Tells how photography is necessary to record today's engineering methods and product development; to provide the necessary visual evidence of the results of safety testing procedures required by government regulations and standards.)
- Escen, P. A. "Sixty-foot tripod is big challenge" *The Professional Photographer* 108, (#2034). Nov, 1981. P. 56-57. (Tells of the use of time lapse photography to document construction.)
- Moore, A. T. and Pinelli, T. E. "High-Speed Imaging an Important Industrial Tool." *Technical Photography* 18, (#5). May, 1986. p. 22-25, 44. (Tells how high speed photos can be used to accurately and precisely measure such things as angles, velocities, failure points and deflection.)
- Davidhazy, A. "There's more to a blur than meets the eye." *Tech Directions* 52, (#6). January 1993. p. 13-15. (Tells how basic photographic tools can be used to measure rotation rate and velocity.)



Glossary of Terms

Aperture - The lens opening through which light passes to reach the film.

Astrophotography - Photography of astronomical subjects such as the moon, stars, planets, meteorites.

Blockout - A material that is used to seal around the screen frame and cover any non-printing areas where ink might penetrate.

Clip-art - Collections of digitized, copyright-free illustrations which can be included in documents.

Clogging - Drying of ink in the screen.

Coated paper - Paper surfaced with white clay or an acrylic substance to provide a smooth printing surface. Coated paper is usually glossy but can be dull.

Composition - Assembling of characters into words, line, paragraphs of text for print reproduction. Arrangement of subject matter into a picture area.

Desktop publishing - Process involved in using the computer to layout & publish documents.

Digitizing - Converting a graphic image from analog to digital form.

Direct input - To input data manually into a computer; may be done through use of a keyboard, mouse, stylus, or light pen.

Emulsion - The term used for the light sensitive material used in photo stencils and photo films.

Font - All numbers, letters and other characters of a particular typeface.

High-speed Photography - Images made using a brief shutter duration or short duration electronic flash. Used for motion analysis. Also called stop motion photography.

Imagesetter - Output device that outputs high-resolution type and images. Creates highest quality reproduction of all output devices used in desktop publishing.

Indirect input - Inputting data electronically into a computer; most common indirect input device in desktop publishing is the scanner.

Kerning - Adding or reducing space between letters of text.

Layout - (1) Drawing of sketch of a proposed printed piece; the working diagram for a printer to follow. (2) Short for layout sheet.

Paper guides - In screen printing used to position paper beneath the screen so the image is printed on the paper in the same position each time. For most work three guides are used. Guides can be heavy cardboard, plastic, metal strips or tape.

Printing screen - The carrier or holder for the screen fabric.

Point - Unit of measure used for designating type sizes and leading. Twelve points equal 1 pica; 72 points equal approximately 1 inch.

Point size - Size of type. Point size indicates the approximate height of the type in points when measured from the bottom of the descenders to the top of the ascenders.

Reclaiming - Removing the stencil from the screen fabric.

Registration - The precise positioning of objects on a page.

Serif - Small embellishing strokes at the ends of printed letters.

Software - Program that runs the personal computer (PC) system; distributes information to all areas of the PC and directs each area to complete various functions.

Squeegee - The tool used to push the ink through the screen.

Stencil - The medium used to create an image on the printing screen.

Synchronization - Matching the peak of the flash to the complete opening of the camera shutter or the burst of the flash to the action to be recorded.

Water base ink - An ink whose vehicle's binder is soluble in water.

Safety Factors

- The stop-motion photography activity may require the use of safety goggles depending on the action being recorded. The flash trigger current is very low and should not present an electrical shock hazard, but students should be cautioned about touching the terminals when the flash unit is turned on.
- Many of the chemicals and solvents used in screen printing are hazardous. It is important to follow use and disposal instructions carefully.

Instructional Suggestions

Motivation

- Arrange for field trips to graphic arts related industries (camera shop, screen printer, sign-painter, newspaper office)
- Arrange for interesting and knowledgeable guest speakers
- Arrange for ways to integrate graphics communication knowledge and skills into other class work
- Arrange for ways to "show-off" the results of student work
- Make products to market to classmates (screen printed tee shirts, ball caps, etc.)
- Desktop publish the school newspaper.

Prerequisite Information

- Design principles (balance, rhythm, proportion, etc.)
- Knowledge of basic problem-solving methodology
- Basic astronomy (for star-tracer activity)
- Basic photography (parts of the camera, composition basics)
- Basic computer knowledge (working knowledge of computer components and how to learn software applications)

Demonstrations

- How to handle and operate a camera (involve fine arts instructor)
- Basic spreadsheets operations (involve business teachers)
- Stencil preparation for screen printing
- Use of screen printing squeegee
- Basic commands for desktop publishing program (include the language arts teacher)

Academic/Enrichment

- Involve students in design and production of school publications (newsletters, yearbook, athletic programs, etc.)
- Engage students in futuring activity
- Have students do an independently arranged advanced level project
- Have students interact with science teacher to find out how photographic chemicals work, which are toxic, etc.
- Have students interact with computer science teacher to find out how graphic images are stored



Related TAMS

- Introduction to Communication Technology Guide
 - TAM 3 Computer Aided Drafting
 - TAM 4 Desktop Publishing
 - TAM 5 Pinhole Camera
- 1990 Implementation Workshop TAMS
 - TAM 1 Video Synchroclies
 - TAM 6 Graphic Arts Technology
 - TAM 12 Desktop Publishing
- 1991 Implementation Workshop TAMS
 - TAM 5 Thermo Screenprinting
 - TAM 17 Newsletter Design
- Performance Standards Project TAMS
 - TAM 7 Video Production/Audio Production
 - TAM 16 Computer Aided Drafting

Assessment/Evaluation Suggestions

- Develop a list of criteria which will be used in either instructor, peer, or self assessment for all products produced in the TAM. For example, criteria for the screen printed image might include: Image crispness, proper placement on a tee shirt, pleasing design, etc.
- Use the developed criteria to prepare a checkoff sheet for evaluation.
- Develop a list of items which should be included in a student's graphic communications portfolio (writing samples, photos, screen-printed images). Include the scoring, rubric, self assessments, peer assessments, etc.)
- Develop a list of criteria for addressing the processes involved in doing a graphic communications activity. For example, the screen-printing process could include preliminary sketch preparation, proper registration setup, good squeegee handling, and cleanup.
- As much as possible, create opportunities for students to peer and self assess their work.

Note: Review the assessment items which are presented throughout the Performance Standards TAMS for ideas which can be adapted for this TAM. You should also refer to the Performance Standards Implementation Handbook for additional assessment examples and ideas.

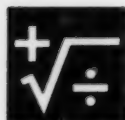
Summary

Graphic communications technologies are changing very rapidly. Chemical photographic processes are rapidly being replaced by electronic and computer driven methods. Expensive typesetting is giving way to desktop publishing. Compact disk players contain encyclopedias, pictures, animation and sounds. Many of the rewarding careers of the future will be found in the exciting field of graphic communications technology.

By Drew Charles, Marcia Kelly Nelson & Tom Trewyn



Technology & the Living World



Mathematics



Communications



Science



Social Studies



Fine Arts



Health



Technology

Goal

The goal of this TAM is to expose students to some key concepts, issues and ideas related to biotechnology through the use of hands-on experiences.

Performance Standards

- Speculate the future of various areas of biotechnology, including those related to human gene alteration, foods development (plant and animal), population control, and disease prevention.
- Identify typical applications in which biotechnology is effectively used, such as medicine, environmental control, and foods development.
- Describe how biotechnology relates to other areas of technology.
- Recognize and analyze the potential positive and negative impacts of the increased use of biotechnology on society.
- Practice all safety and ethical procedures when constructing biotechnology products.
- Identify career options and foundation skills involved in pursuing a career in biotechnology.
- Develop a design for and solve problems related to constructing a simple biotechnology project or experiment.
- Communicate orally, visually and/or in writing the principles included in the design and construction of a biotechnology project or experiment.
- Demonstrate the proper care of and ability to work with highly specialized laboratory equipment.
- Define those practices and terms used in biotechnology, including biomass, gene splicing, bio-degrading, and hydroponics.



Introduction

Biotechnology refers to a range of technology associated with life. Animal and plant life as well as human life are included. Biotechnology is one of the newest recognized technological studies, yet probably the oldest form of any of the technology systems.

Biotechnology, being a combination of biology and technology, uses living organisms to alter processes and develop products. In some cases the living organisms may be changed or altered. One of the most recent examples has to do with genetically engineered tomatoes. One research group in mid-Kansas is attempting to combine hearty and disease resistant "weeds" with grain crops such as wheat, corn and rye. The idea is to develop varieties which can survive and even thrive under extreme conditions. This is all part of biotechnology.

Of course, all of this raises serious ethical issues. Throughout history, there have been experiments sanctioned by governments (Hitler in WWII, radiation testing in the U.S., etc.) which have tragically affected human lives.

On the positive side, virtually all of the wonder drugs and many of the foods which have improved the quality of life and which have increased the lifespans of humans are the result of biotechnology. So, biotechnology is an exciting and critically important area of study.

As indicated above, **Agriculture Technology** is probably the most widely studied area of biotechnology. It is better known as farming or ranching. It is responsible for producing plants, food and animals for use by humans.

Environmental Technology is becoming more and more important everyday. Everything that effects our natural environment can fall into this category. One primary concern we have at this point is our waste. This includes industrial waste like chemicals and pollutants entering our streams and rivers. Our household garbage and trash is becoming a problem in our landfills. This is not to mention the damage which has been done by automotive pollution and deforestation. We only have one world and we need to learn how to take care of it.

Objective Statement

The activities described in the following pages represent samples of activities which can be used to deliver these performance standards. Many additional activities can and should be used. Extreme care should be taken to connect each activity with appropriate activity objectives as well as with the performance standards listed on page 1. These objectives should be developed by the instructor and should be shared with and made clear to the students.



Technology Idea

Identify and discuss the qualifications required for as many bio-related technology careers as you can think of. Since the technology is expanding so rapidly, try to identify new careers which you think are likely to open up over the next decade. What kinds of background and education will these careers likely require?



Integrated Activity Idea

Discuss agricultural products from other countries. Why are these products grown in other countries?



Integrated Activity Idea

Have a class debate on the following issues: Should large cities be required to separate out the organic waste to be recycled into energy? Should surplus agricultural crops be converted to fuels such as methane gas or alcohol rather than being fed to animals? Would this lead to a better energy distribution around the globe? How?

Activity 1

Terrarium - A Micro-Environment

The terrarium garden provides a means of observing the entire process of growth which is contained in a small observable and controllable area. It efficiently uses and reuses the various elements present to fulfill its needs to maintain life. A terrarium is much like the biosphere. In fact, many ideas and natural processes that occur in the terrarium were adapted to sustain human life in the biosphere experiment which has been going on in the southwest. The biosphere and the terrarium help us in studying conservation and recycling the various natural elements on earth.



Figure 1 - Photosynthesis

Figure 1 is a diagram showing the process known as the rain cycle. The thick arrows represent evaporated moisture, H_2O energy and O_2 being released into the air by the plant during photosynthesis. The thinner arrows represent O_2/CO_2 being absorbed and recycled into the atmosphere.

Plant Selection

Slow plant growth is desirable in a terrarium, so selecting plants is very important. Generally speaking, the number and size of your plants will depend on the size of your container. You will need to choose plants that prefer high humidity, moist soil, constant temperature and low light conditions. Consult your local greenhouse or choose from the list below.

- Begonias-most any of them
- Boston ferns
- Bromeliad-a choice of many
- Corn plant



- Wood fern
- Holly fern
- Bead plant
- Round leaf fern
- Swedish ivy
- Devil's ivy

This is only a small list of what will grow well. You will need to consult your local greenhouse to see what they recommend and what is available at a reasonable price.

Terrarium Preparation

1. A narrow necked bottle is best to use for the terrarium, but any glass container that can be closed will work well. To use two liter bottles, remove the black molded base from the bottom of the bottle. Cut the bottom off the bottle; then use the black molded base as the bottom of the bottle. Reinsert the top portion into the bottom. This method is very inexpensive and makes planting easier.
2. After selecting your plants, prepare the soil layer. Approximately 1/4 of the container is used for the planting soil. In addition to potting soil, the terrarium will need a layer of drainage rock and a layer of charcoal. (See Figure 2.)
 - The soil should be a commercial grade potting soil.
 - The charcoal can be chunks of broken regular "Barbecue" briquettes.
 - Drainage rock can be clean, thumbnail size stones. Aquarium rocks are ideal for this purpose.

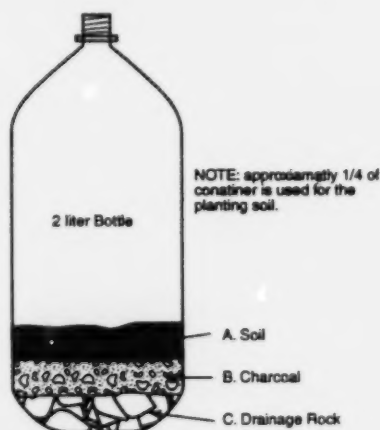


Figure 2 - Soil Layers

3. If your terrarium has a small neck you will need to improvise some tools to use. Consider using a long narrow paper funnel to put the layers of growing medium into the bottle.



Integrated Activity Idea

Study the root words of the scientific names of the plants on the plant list.



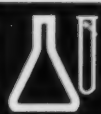
Integrated Activity Idea

Develop a small-scale hydroponics system. Experiment with pH levels as well as with various toxins. Discuss the advantages of hydroponic systems over soil-based systems.



Integrated Activity Idea

Why do some plants do better in terrariums than others?



Integrated Activity Idea

Pursue bottle biology experimentation in more depth. Activities have been developed for making a compost column, a TerraAqua column, ecocolumns, predator-prey columns, etc. For more information write: Bottle Biology Project, Dept. of Plant Pathology, University of Wisconsin, 1630 Linden Dr., Madison, WI 53706.



Integrated Activity Idea

Coat the bottom of a leaf with petroleum jelly. Plants absorb carbon dioxide from the undersides of their leaves. Analyze the leaves after a passage of 1, 2, and 3 days. What do the results indicate?

4. When you're ready to plant, other tools will be needed. Try using long pieces of 1/4 inch or 3/8 inch doweling. A cork added to the end of the stick will give you a soil tamper. A wire loop can be used to place plants.

Watering (Establishing the Rain Cycle)

1. The key to watering is to take it easy and go slowly. Avoid the tendency to over-water.
2. Add only small amounts of water and then check at regular intervals. Look for signs of dryness—drooping leaves, dry soil.
3. Too much water is the main reason for failure. Remember, you can always add more water.
4. A fine mist sprayer is best for any watering needed after initial watering.
5. Manipulate the variables in your terrarium and observe the results. You may wish to establish a series of small terrariums which will make it easier to experiment with different variables.
 - amount of water and degree of humidity
 - amount of sunlight
 - level of carbon in soil
 - level of carbon-dioxide in atmosphere
 - earthworm concentration in soil
 - Insert an invertebrate animal
6. The experiment can also be taken a step further by intentionally selecting a variety of different soils (sandy, low pH, high pH, potting soil, clay, high calcium, high hydrogen, etc.) It is very important to keep accurate records in order to check hypotheses. Compare the results with what you hypothesized would occur.
 - a. Which variables appear to make the plants healthier? Why?
 - b. Which variables have a negative effect? Why?
 - c. What is the function of the drainage rock in your terrarium?
 - d. What does the charcoal do in the terrarium?
 - e. What is different about potting soil than other soils? Explain.
 - f. What did you learn from this exercise that has implications for the environment?

Materials Needed

2 liter bottle
Crushed charcoal
A variety of homemade tools for planting.

Potting soil
Drainage rock
Plants



Activity 2

Making & Recycling Paper

We get lots of information about recycling things today. Most communities have programs for recycling many things, including paper, bottles, aluminum cans, newspapers and tires. Automobiles, lawn cuttings, garbage and even human waste are candidates for recycling.

So, the question isn't about what we can recycle. Instead it should be about what we can't recycle. But often the question is whether it is worth the trouble.

Here are some facts to consider. In 1990, some modern day archaeologists started exploring and digging in our landfills. They found newspapers from 1952. We always thought food products and yard waste degraded quickly. But they found four-year-old hot-dogs and heads of lettuce ten years old. So, obviously, landfills, as they exist today, are not the answer.

One of the biggest problems is paper and paper products. Newspapers, old boxes and office waste in the form of paper together account for 35% of all landfill space. And the problem isn't just with landfill space. The deforestation which must occur to provide wood based products is harmful to the atmosphere and forest wildlife. Resources must be conserved. One way of doing this is by recycling paper. It is a good way to save trees and conserve landfill space. Recycling paper can have more impact on our natural world than any other single practice.



Technology Idea

Research the process of digesting biomass using an anaerobic generator to produce methane gas. Then construct and test a methane digester.

How Paper Recycling Works

1. Bundles of used paper are fed into a pulping machine
2. The pulping machine operates much like a large blender. The paper is shredded and mixed with water, and the filtered residue is then moved to a screening machine.
3. In the screening machine paper and water pulp are cleaned and forced through finer and finer screens.
4. De-inking: Pulp is pushed through a screen which filters out the ink.
5. Bleaching: Pulp is then bleached to bring the brightness level up.
6. The pulp is then passed through a papermaking machine that forms and flattens the pulp into sheets and squeezes the water out. The recycled paper is cut and wound into 1,800 pound rolls.

It's not any less expensive to recycle paper than to make it from new pulp. But it saves trees and therefore is an excellent recycling project.

Procedure



Integrated Activity Idea

Trace the historical development of paper. How has the technology changed? Have most changes been as the result of economic, technological, or social reasons?

Making Pulp

1. Place very small pieces of paper in a large container of warm water overnight. They will need to sit for a period of time until the paper has been thoroughly saturated.
2. Stir the water until the paper is completely dissolved. For best results, use a blender until the mixture has been thoroughly mixed (about 15 sec.). It is very important that the paper fibers be suspended throughout the water. The water will appear cloudy but smooth (about the consistency of a smooth cream).
3. Add liquid starch to the pulp mixture. Add the starch in a ratio of 1000 to 1. Example: 15 liters of pulp to 15 milliliters of starch or 6 to 7 gallons of pulp to 1 ounce of starch. It will depend on the size of container and mold you wish to use. (You may also wish to liquidize some cotton linters to add to the mixture. It will improve the paper quality).
4. In addition to recycling paper, you can also use a number of other fibrous materials (flowers, celery, rhubarb, etc.). To prepare these materials you will wash away as much of the non-fibrous material as possible by placing the well-soaked plant particles onto a cheese cloth and then running water through it until clear.



Integrated Activity Idea

Paper is a major problem in landfills, garages and offices. Conduct a debate on the advantages and disadvantages of a totally paperless society. Include implications for society's various institutions, including education (books, libraries), banking, retail stores, publishing (magazines, newspapers), artistic expression, etc. Could our society function without paper?

Making Paper

1. You will need to make a mold and deckle. Mahogany works well for the frames because it doesn't tend to spot and warp when wet. The mold and deckle is illustrated in Figure 3.

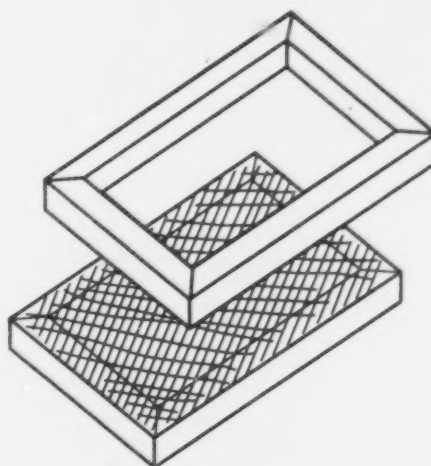


Figure 3 - Mold and Deckle



2. Fill your pulp container with enough pulp so that there is room to submerge both the mold and deckle into the liquid. Don't overfill the container or you'll make a mess when you submerge the mold and deckle into the pulp solution. **Instructor Checkoff.** ☐
3. Next, stir the solution until everything is thoroughly mixed. You'll want to work quickly so that the solids in the pulp solution don't have time to settle out.
4. Place the deckle and mold together as shown in Fig. 3 and then scoop the assembly into the container. It should be a kind of scooping or dipping motion where you move the assembly in vertically and flatten it out as you continue to immerse into the liquid.
5. Gently move the mold and deckle assembly in the horizontal position enough so that the fibers will distribute evenly over the screen. Don't make these movements too rapidly. Some gentle movement will do just fine.
6. Next, lift the deckle and mold assembly out of the solution. Make certain that you maintain a horizontal position so that the pulp solution doesn't all run to one side.
7. After you are up and out of the solution, it is a good idea to quickly shake the filled mold from side to side (not too hard) to make sure the solution has been evenly distributed and is settled into the screen openings.
8. Allow the excess water to drain from the solution. You can hold the mold and deckle or you could prop it on some make shift stands. The important thing is that it stay in a horizontal position until the pulp material has a chance to begin to set up.
9. As soon as most of the excess water has drained from the pulp (and as soon as possible after having dipped the pulp from the container), you will want to remove the mold from the deckle. Lift it off carefully making certain that extra pulp doesn't drip onto your nicely flowed sheet. If this happens your paper will look like it has drop in it or it may even create a crater or hole.
10. Let the "paper" set until most of the water has had a chance to drain off (but don't let it dry completely).
11. Place a sheet of blotter paper onto the paper while it's still in the mold and turn the mold over. Press the mold and paper down against the blotter paper to help remove any remaining moisture.
12. Next, lift the mold away from your new paper. Be careful and go slowly so that you don't tear your new paper. It will still be rather "green."
13. The quality of your paper will be improved if you can press it at this point. It isn't necessary to do this one sheet at a time. If you have made multiple sheets, simply stack them up with a sheet of blotter paper in between. Apply pressure by stacking heavy objects on top of the stack. It is a good idea to place something with a smooth and firm surface on top of the stack (like a piece of 1/4 plate glass).

14. After the paper has been pressed in the stack you can further press it a single sheet at a time using a house hold Iron.
15. The final step is trimming the edges to size. Just use a standard paper cutter or a pair of scissors.

You will find that this paper is very absorbent, much like a paper towel. A coating can be applied to the paper in the following manner:

1. Dissolve 12 ounces of unflavored or, if you like, flavored gelatin in 1 gallon of water.
2. In a flat pan, dip the paper quickly and allow it to dry flat or hanging on a line.
3. Press or roll the paper to help it dry.

Problem Solving Follow-ups

1. What ratio of water to paper seemed to work best? Why?
2. Experiment with toilet paper, typing paper, a Big Chief tablet, and a newspaper. What type and quality of paper worked best for recycling? (Note: almost anything can be made to work if you use a blender.)
3. What difference does the screen size make?
4. Experiment with various materials (called sizing) to seal the paper (such as wax, lightly sprayed lacquer, starch, wallpaper adhesive, PVA emulsion, etc.). Why do these work or not work? What process is used in industry?

Materials Needed

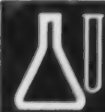
Large tub-needs to be sized to accommodate your mold 5 to 6 gallons, fairly shallow (4 to 5 inches)
Mold-(with screen wire) and deckle
Tissue or scrap paper
Starch
Blender (optional, see note)
Shallow pan-2 inches deep.
Household iron
Blotter paper



Activity 3

Filtration and Purification

Over the past half century we have developed many wonderful products to increase the length and quality of our lives. Many of these products required not only biological processes, but at times, synthetic processes that involve chemicals. Think, for example, about fertilizers, herbicides, pesticides, medicines, and much more. But many manufacturing processes produced wastes that have not been disposed of properly or with the proper precautions. As a result, we are now in the middle of locating and cleaning up many areas that are contaminated. Many of these hazardous waste products have contaminated our water supplies. Lakes, rivers, and oceans all became convenient places to dump waste. Some of this waste found its way to the underground water supplies we use for our household water. Now we are faced with the problem of making this water suitable for human consumption. In extreme cases, entire communities have been relocated because the hazards were simply too great. This activity will involve making and testing a basic water filtration and purification device.



Integrated Activity Idea

Check with your chemistry teacher to see what contaminants are in your local water supply. What effects can they have on plants, animals and people?

Procedure

Make a Water Filter

1. Cut the bottom off a 1 or 2 liter plastic bottle.
2. Pack cotton into the neck of the bottle. See Figure 4.

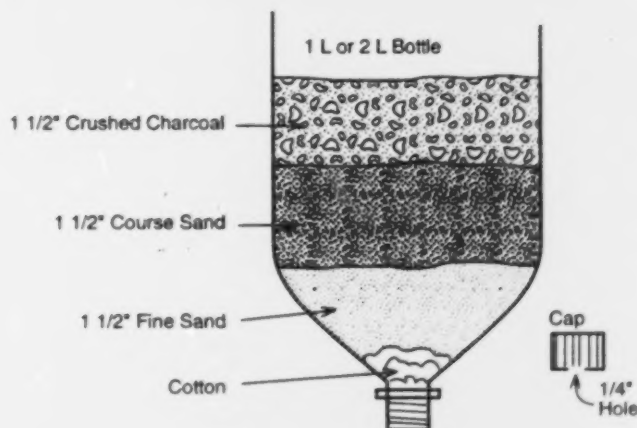
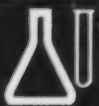


Figure 4 - Water Filter



Integrated Activity Idea

Conduct an analysis of water from the school. What kinds of micro-organisms and bacteria are present which would be harmful in larger quantities?



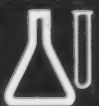
Integrated Activity Idea

Consult with your science teacher to find out what kinds of contaminants cannot be removed from water using filtration methods. How would these be removed?



Integrated Activity Idea

What social and cultural factors have impacts on water pollution? Compare industrial, agricultural, urban and rural causes of water pollution.



Integrated Activity Idea

Describe the process used in desalination plants in Kuwait which were sabotaged during the Persian Gulf War.

3. Drill a 1/4 inch hole in the bottle cap. Clean the edges of the hole with a small file or sandpaper to remove any sharp edges or loose filings.
4. Place the cap on the bottle.
5. Put the fine sand into the bottle. Continue to add sand and gently pack the sand until it is about 1 1/2 inches deep.
6. Now add coarse sand in the same way until it is also about 1 1/2 inches deep.
7. Add the final layer of 1 1/2 inches of lightly packed crushed charcoal.

Test Your Filter

1. Pour the contaminated water into the top of your filter. Note: A quart jar will hold your filter upright and collect the water that passes through your filter. Numerous contaminants can be used including many which are common in the real world. You may wish to experiment with: soil, dye, koolaid, lawn fertilizer, motor oil, salt, animal waste.
2. Begin with bottled (dechlorinated) water. Mix in the contaminate (1 per sample). Keep track of the amount added and record on your data sheet.
3. As you pour the water into the filter, be careful not to pour too fast. You may overflow the filter or not have enough room to collect what you pour.
4. Test the filtered water. Testing can be done in several ways. The simplest is visual inspection. Observe the sample for changes in color and smell. Record your observations. You can also test your water samples chemically. One type of testing can be done using chemicals used for evaluating the quality of swimming pool water. These typically test pH and chlorine (or bromine) levels. A more sophisticated process is to use the type of water analysis kit typically used in science classes (available from science vendors such as HACH, P.O. Box 389, Loveland, CO 80539, (800) 227-4224). These kits include tests of ammonia, nitrate, dissolved oxygen & pH levels. The most sophisticated type of testing would need to be done at a research lab specializing in water analysis. You may wish to explore this possibility in your community.
5. After completing your experiments, record and graph your results. Based on this information answer the following:
 - Which contaminants were the most difficult to filter out using this type of filtration device?
 - How could the filter have been adapted to be more effective?
 - Based on this experience, what contaminants seem to be most harmful to the ground water quality?
 - How does your filter compare to the technology used at (a) sanitary landfills and (b) water purification plants?



Materials Needed

1 or 2 liter pop bottle with cap.

Knife or cutting tool for bottle

Cotton

Fine Sand

Course Sand

Crushed Charcoal

Contaminants

Labels for Samples

Quart Jar

Activity 4

Propagation/Tissue Culturing/Cloning



Integrated Activity Idea

Conduct a debate on the desirability of genetic engineering in humans. Include topics such as disease control, cosmetic changes, enhanced intelligence or athleticism, and bionics. What about it? For or against?

Genes are a part of every living thing. Genetics is the study of these genes and how they affect our makeup. Genes determine all of the characteristics of an organism. For example, your genes determine your hair and eye color, your general body shape and size and even your general health and how prone you are toward getting serious diseases.

Genetic Engineering has received a lot of attention lately. Some people feel that we are on the edge of being able to use our knowledge of genetics to treat or possibly eliminate diseases such as diabetes, cancer, and muscular dystrophy. Others feel we are playing God by experimenting with our genetic make-up. Genetic engineering can be very beneficial. It can help us grow stronger, more productive plants and engineer animals that can produce more meat and milk for human consumption.

Genetic engineering methods allow us to change, vary, and hopefully, improve many reproductive processes. For example, technologists can alter natural genetic processes to make plants more disease resistant, and increase their tolerance for cold and dry conditions. Corn has been improved to make it more nutritious and able to grow in colder climates. Other plants have been altered to produce larger fruits and vegetables for longer periods of time. Fruit trees have been crossed to develop trees that will produce fruit year round and will never get larger than about 3 feet tall.

Once the ideal plant has been developed, it can be reproduced through propagation or tissue culturing. A clone or an exact duplicate of the original can be grown.

Why is this biotech? Genes can be inserted which incorporate herbicide resistance, alter or change flower pedal color, improve insect resistance, viral resistance, fruit ripening time, environmental stress, drought resistance, etc.



Integrated Activity Idea

Experiment with grafting branches from fruit trees to other varieties. How does this process work? How is it similar to and different from tissue propagation?

Procedure

1. Prepare the rooting container

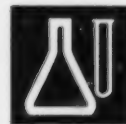
- Fill the rooting container about 3/4 full with sterilized soil.
- Add a few drops of water with the eye dropper.
- Close the container.



2. Prepare/plant the tissue sample

- Using the small scissors, trim the suggested size sample (about the size of a pea) from the parent plant. Carrot root, leaves from kalan choe, African violets, and Boston ferns are among those that work well.
- For best results dip the cut edge of the sample into the growth hormone.
- Gently plant/push the cut edge into the soil (you will want to use Agar) in the rooting container. Lay your sample on top of the soil.
Instructor Checkoff ☐
- Label your container and place it into the growth rack. **Note: sterility is absolutely critical in order to protect your sample from contamination from bacteria or fungus. Your experiment will not work unless these conditions are carefully maintained.**
- After 3 to 5 days, check your sample.
 - ◆ Look for new growth.
 - ◆ Look for rooting.
 - ◆ Look for response to light.
 - ◆ Add 2 to 3 drops of water.

After your sample has taken root, it can be transplanted to another growth bed to provide more room for roots and foliage development.



Integrated Activity Idea

Investigate the development of the "flavor savor" tomato. How was this done? Why did it work? What are the implications for genetic engineering of other plants? What about humans?

Materials Needed

Parent plant
Small scissors
Growing container (sterile Petri-dishes with lids)
Growing medium (Agar - available from biological supply houses)
Root & Growth hormone (rooting powder - optional) - available @ any nursery
Eye dropper



**Integrated
Activity Idea**

Visit the archives of a local newspaper. Attempt to identify any information regarding ground water quality problems which may have appeared in the paper over the past decade. What were the sources of contamination? How was the problem resolved?

Activity 5

Toxicity Testing

Throughout history humans have used the toxic effects of chemicals for their betterment in many ways. The study of these "poisons" has developed into a sophisticated science called toxicology. Egyptians (Papyrus), ca. 1500 BC, Hindus (Vedas), ca. 900 BC, Greeks (Hippocrates and Aristotle), and Chinese ca. 400-300 BC, studied poisonous compounds for use as medicines, for suicide, or removal of a political figure. Paracelsus (1493-1541 AD) formulated many then revolutionary views that remain an integral part of the present structure of toxicology. One of the foremost philosophies of science that Paracelsus formed was that any chemical can be toxic, it is the dose that distinguishes between therapeutic and poisonous. This particular dose-response relationship is one of the foundations of modern environmental and human toxicology.

"Toxicity" is a relative property of a chemical which refers to its potential to have a harmful effect on a living organism. "Toxicity testing" is used to assess that potential of a contaminant to affect fish and wildlife populations, and human health.

Common duckweed (*Lemna minor*) can be used as a toxicity measuring tool. It can be thought of as a kind of biological instrumentation tool. Because of its broad sensitivity range, it is used as an indicator species to test all kinds of water use and runoff situations (landfills, reservoirs, agricultural runoff, etc). Duckweed does not measure the degree of contamination or identify the contaminant(s); other tests and analyses are needed to assess these issues. But, a toxic response of duckweed suggests that water quality has been affected and further testing is necessary.

Duckweed is a floating aquatic plant found worldwide. The structure of the plant is in two-parts: fronds (leaves) and roots. The plants grow in colonies and form aggregates of two or more fronds. Duckweed grows very fast, doubling rapidly in frond number. As its name suggests, Duckweed is a major food of waterfowl, but muskrat, beaver, and fish also eat them.

1. Cut the bottom off a 2 liter soda bottle 1/2" above the black coated area. You will want to make 20-30 of these containers, depending on the number of toxins you wish to test. You should arrange for 3 samples of each toxin in order to compare results.
2. Fill the container with water up to the top of the blackened area. Measure the volume. An accurate volume measurement is important to provide for good experimental control. Also, make certain that the containers have been thoroughly washed and rinsed.



3. Mix a variety of toxins. Possibilities include:

Laundry Detergent (liquid powder)*	Rubbing Alcohol	Coffee
Dish washing detergent (liquid)*	Hand lotion	Ink
Dishwasher detergent (liquid or powder)*	Baby powder	Finger paints
Hand soap (liquid)*	Facial astringent	Pepto bismol
Fruit Juice	Salad oil	Deionized water*
Coca-Cola	Milk	Gatorade
Pepsi	Scouring powder	Vitamin C
Dr. Pepper	Fertilizer*	Pixie Sticks
Mountain Dew	Acne medicine	Food coloring
Toothpaste	Road salt*	Elmer's glue
Mouthwash	Table salt	Rit clothes dye*
	Alka Seltzer	Kool Aid
	Cough Medicine	Asprin
	Sweet and Low	

* Indicates that this product has environmental concern.

The mixtures should be 10 parts "Hoagland's" solution to 1 part toxin (as a starting point).

4. Pour the toxic solutions into your clean containers. As indicated above, you should use 3 identical samples of each toxin to ensure accurate results. Be certain to label all containers. It is best to use coded numbers to conceal the identity of the toxins. This will reduce the possibility of error due to bias. Note also that you will want to include several samples of pure Hoagland's solutions as a control group.
5. Before placing the duckweed into the solutions, develop a hypothesis of what you expect the plant to do in the solution. Record your hypothesis for each toxin.
6. You are now ready to place the duckweed into the solutions. Place 12 fronds into each container. One frond is equivalent to one dual shaped "leaf". The duckweed plant pictured in Figure 5 has 3 frond's. Note that the small developing frond is not counted. (You will want to use a hand held magnifying glass to view the plants since they are quite small).

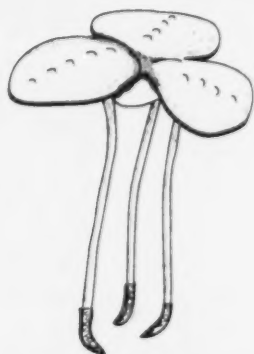


Figure 5 - Duckweed Plant



Integrated Activity Idea

Duckweed is a commonly used biological "instrument" used for measuring toxins. Consult with a research biologist (or a science teacher) to identify other examples of the use of plants as "instruments."

7. You are now ready to begin observing the results. Remember that the duckweed is serving as a measuring tool or "indicator" of toxicity. Using table on page 21 record the number of fronds for the control and toxic samples at 0, 24, 48, 72, and 96 hour intervals. At the same intervals record your "questionnaire" observations (color, root, appearance, breakage, etc).
8. Additional control tips which should be maintained equally for all samples include 25 degree Celsius temperature, lid on top to slow evaporation (but do not seal completely), standardize light exposure with a grow light and timer (8 hours off, 16 hours on).
9. After all of the observations have been computed, compare your results with your hypothesized outcomes. Complete the following questions and activities.

Materials Needed

2 liter bottles (to be cut)
 Duckweed
 Labels for bottles
 Grow lights
 Timer
 Funnel
 Hand held magnifying glass
 Data sheets
 Graph
 Temperature control
 Hoagland's solution

Activity contributed by Marcia Kelly Nelson

Quantitative Results - Frond Count

Test Number	Treatment	Hrs. of Exposure				
		0	24	48	72	96
1	Control					
2						
3						
4						



Qualitative Results

Include comments on any changes in plant color, root development or breakage, colonies breaking apart, general frond size, etc.

0 Hours	Time _____	Date _____
Control	Observations	_____
Treatment #1	Observations	_____
Treatment #2	Observations	_____
Treatment #3	Observations	_____
24 Hours	Time _____	Date _____
Control	Observations	_____
Treatment #1	Observations	_____
Treatment #2	Observations	_____
Treatment #3	Observations	_____
48 Hours	Time _____	Date _____
Control	Observations	_____
Treatment #1	Observations	_____
Treatment #2	Observations	_____
Treatment #3	Observations	_____
72 Hours	Time _____	Date _____
Control	Observations	_____
Treatment #1	Observations	_____
Treatment #2	Observations	_____
Treatment #3	Observations	_____
96 Hours	Time _____	Date _____
Control	Observations	_____
Treatment #1	Observations	_____
Treatment #2	Observations	_____
Treatment #3	Observations	_____

Debriefing

Directions: Graph your data using the number of duckweed fronds as the dependent (Y-axis) and time as the independent variable (X-axis). Graph all four treatments for one school on a single graph, using a line method since growth is continuous data.

- What does the plot of this data tell you about duckweed growth?

- Did your data support your hypothesis? Why or Why Not? Note: The results should be different for each toxin!

- Were there any results that surprised you? Which ones and why?

- What are the conclusions you can infer from these results? For example, what affect do you think some of these chemicals tested might have on the food chain in a pond or wetland ecosystem?

- What do you know about chemicals and toxicity that you didn't know before this toxicity test?

- How can the most environmentally damaging toxins be neutralized or removed from the ecosystem?



Activity 6

Gravitropism

Gravitropism has to do with the stimulation of plants by the force of gravity. Actually gravitropism is only one type of "tropism". There are:

Tropism Name	Plant Responses to Stimulus
Chemotropism	response to chemicals
Gravitropism	response to gravity
Hydrotropism	response to water
Phototropism	response to light
Thermotropism	response to heat
Thigmotropism	response to touch

This activity will focus on "Gravitropism". The implications are especially important for the future when we're going to be growing plants in space. Gravity affects both root and shoot growing portions, but in opposite directions. Roots grow towards gravity (positive gravitropism), shoots grow away from gravity (negative gravitropism). These tropisms are due in part to plant hormones that stimulate plant growth activities. A plant's perception as to the direction of gravity depends on the settling of particles within the plant cells. This cell elongation results in a movement of the plant away from the side where elongation occurred, or opposite that of the gravitational force (see Figure 6).

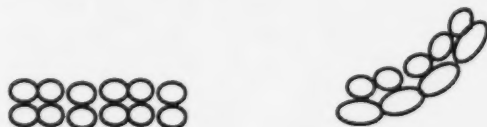


Figure 6 - Cell Elongation

For the experiment you will also need to know how to calculate centrifugal forces. Centrifugal force is an outward force that acts upon mass rotating about an axis. Centrifugal force is generally expressed in multiples of the force of gravity, or F_g (also referred to as G's). For this experiment it is necessary to calculate the relative centrifugal force on the plant. The magnitude of centrifugal force exerted on an object depends on its angular velocity and distance from the center of rotation. Thus, relative centrifugal force F_r is calculated using the following equation:

150



Integrated Activity Idea

Identify a method which could be used to experiment with the other forms of tropisms (other than gravitropism). How could you build them into a space station simulation?

Equation 1: $F_c = 0.204v^2/D$

Where v = peripheral speed of the film canister in meters/sec
 D = diameter of the circle of rotation in meters

Equation 2: $v = (C \text{ meters/rev})(n \text{ rev/min.})(1 \text{ min.}/60 \text{ sec})$

Where C = distance in meters the film canisters travels each revolution.
 n = number of revolutions each minute the canister is turning (RPM).
 To solve C calculate in meters the radius of the circle of rotation (measure diameter then divide by 2); then, calculate the circumference using the equation.

Equation 3: $C = 2\pi \text{ radius}$

Where $\pi = 3.14$
 radius = radius of the circle of rotation
 Calculate n by determining the revolutions per minute that the table is rotating; then solve v .

Equation 4: $v = (\text{_____ meters/rev})(\text{_____ rev/min.})(1 \text{ min.}/60 \text{ sec})$

Apply v to the above equation (#1) to determine the relative centrifugal force the plants are experiencing in the test.

Procedure

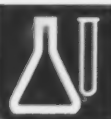
1. Cut small squares of "inner-facing" (stiff cloth used to stiffen collars, charts, etc. in sewing) to line approx. 1/3 of the interior of a film canister.
2. Wet the square (use bottled water-non chlorinated) and press into the canister.
3. Cut a small slip of a Wisconsin fast plant (about 5 days old). The total length should be less than the diameter of the canister.
4. Attach the leafy part of the plant to the wet inner facing material. The stem should extend horizontally from the side of the canister. The water will adhere the leaf to the innerfacing. Lay the lid on top, but do not seal tightly.
5. To do the experiment, designate some canisters as control and some for geotropic testing. Label each.
6. Place the geotropic samples on the outside edge of a record player turntable. Start the turntable. This will generate centrifugal force and change the direction of "gravitational pull".
7. Use 3 turntables running at 3 different speeds. Convert the data and record in the table on page 21.
8. The changes to be recorded are in terms of the angle of the stem from its original horizontal position.
9. After gathering the data and computing the computations, complete the follow-up discussion questions.

**Gravitropism Test Data***Angle of Change in Plant Stems*

		Experiment's Units			
		Earth's Gravity	Turntable #1	Turntable #2	Turntable #3
Time 0	Time_____AM/PM				
Time 1h	Time_____AM/PM				
Time 2h	Time_____AM/PM				
Time 3h	Time_____AM/PM				
Time 4h	Time_____AM/PM				
Time 24h	Time_____AM/PM				
Average Degree of Change					

Gravitropism Centrifugal Force Data

		Experiment's Units		
	Earth's Gravity	Turntable #1	Turntable #2	Turntable #3
D (Diameter of turntable)				
Radius of turntable				
C (Circumference)				
n (RPM)				
v (velocity of rotation)				
F_R (relative centrifugal force)				
Beginning Time				
Ending Time				
Duration of Exposure				



**Integrated
Activity Idea**

Design a hydroponics growing area based on information learned from your gravitational activity.

Debriefing

Directions: Graph your data using the average degree of change as the dependent variable (Y-axis) and the experimental units as the independent variable (X-axis). Graph all experimental units on one graph using a bar graph.

- What does the plot of this data tell you about the affect gravity has on plant growth?
- Did your data support your hypothesis? Why or Why not?
- Were there any results that surprised you? Which ones and Why?
- What are the conclusions you can infer from these results? For example, how will plants grow on a space station in the absence of gravity?
- What do you know about the force of gravity and plants that you didn't know before this gravitropism test?
- Based on the results of this experiment, what are the implications for space station design?

Materials Needed

Five day old Wisconsin fast plants
 Inner lining material
 Black film canisters with lids
 De chlorinated water (bottled)
 3 record player (turntables)
 Protractor
 Graph paper

Activity contributed by Marcia Kelly Nelson



Activity 7

Making a Water Soluble Plastic

Plastics are a big part of your daily life. Often when you think a particular item is made of metal, wood or both, you may discover that it is actually a plastic material. Almost all packaging contains some form of plastic material. Observe this the next time you buy something. Everything from lollipops to groceries to TV sets are packaged in plastic. Not only is the packaging plastic, but many parts of the products are also plastic. Most plastics are nearly indestructible. As this industry grows and our use and disposal of plastics grows, what are we going to do? The material is filling up our landfills.

Suppose we could develop a biodegradable plastics material, one that would break down biologically when we disposed of it. It would most likely be much different than the plastics we have today. Would it be just as good? What problems might we have with it?

This activity shows you how to make a water soluble plastic material. Make the plastic, and compare and contrast it with ordinary plastic materials. Do you think it could help solve some of the problems we now have with plastics disposal? If it is not perfect, how could it be improved?

Procedure

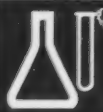
Preparation of PVA and Borax Solutions

It is best if you prepare the PVA and borax solutions in advance. Supplies can be purchased from any chemical house. What you will actually purchase for the PVA solution is 99-100% hydrolyzed PVA.

1. Dissolve 40 grams of the 99-100% PVA in 960 mL of water, stirring constantly.
2. Slowly heat the water to dissolve the PVA solid.
3. Do not heat the PVA above 80°C or you will have coagulation problems.

When you complete this, you have 1000 mL of 4% PVA solution which will be enough for about 30-40 students.

To prepare the borax solution, dissolve 4 grams of borax in 96 mL of water. This will give you 100 mL of borax solution, enough for about 30-40 students. Borax can be purchased at the grocery store.



Integrated Activity Idea

Consult with the science teacher about the chemical makeup of various types of plastic materials. How can each of these be shaped or processes?



Integrated Activity Idea

Paper or plastic? Have the class debate the choice we are asked to make every time we go to the store. What should we choose considering the environment, energy required to produce each, convenience, recyclability, etc.?



Integrated Activity Idea

Conduct a historical study of the development of plastic as a material. Based on past developments, attempt to predict what future types of plastics will be developed as well as what they will be used for.



Technology Idea

Another biodegradable plastic can be made from liquid starch, salt and white glue. Use 1/2 cup liquid starch, 1/4 cup white glue, and 1/4 teaspoon of table salt. Experiment with the results.

Making the Plastic

1. Measure out 3 mL of the borax solution to 25 mL of the PVA solution.
2. Stir the mixture with your stir sticks. A semi-solid substance will form almost immediately.
3. If the substance does not seem solid enough, add more borax solution (add very sparingly).
4. After the gel has formed around the stir stick, lift it up and hold it over the cup. What happens?
5. Place the blob on a paper towel to absorb any excess liquid. Take it in your hands and roll it around into a ball. Describe how it feels.
6. Drop the ball or throw it onto the table. Is it a liquid or a solid?
7. Spread a thin layer of the gel on a piece of glass. Press it out flat, being careful not to break the glass. Let it dry in a warm spot overnight. Lift the thin film from the glass plate.
8. Coat a shallow glass container's bottom and sides with the gel. Let dry. Has the film been molded to the shape of the container?
9. You have made a newly developed plastic material known as polyvinyl alcohol. It will do many things other plastics do. But this plastic material has a characteristic which is unique to plastic. It will dissolve in warm water. Get a small piece of your dried film. Put it in warm water and describe what happens.
10. Continue to experiment with the PVA gel.
 - Can you form a thicker sheet?
 - Can you mold a special shape?
 - Can you speed up the drying?
 - Try to color it with food coloring or water-based marker. Do this when you are first mixing the solutions.
11. Clean up your area very thoroughly.
 - Dispose of any unused PVA.
 - Wash your hands very well.

If plastics could be used as we use them now in our lives, and yet we could dissolve them in water to dispose of them, would this help our plastics disposal problem? What problems could we be creating? If this plastic dissolves in warm water, what could we use it for now? What could we definitely not use it for?

Materials Needed

Stir sticks
4% aqueous PVA solution
Borax solution
Disposable cups
Paper towels.



Activity 8

Sea Urchin Embryology

Embryology is the study of the changes a fertilized egg undergoes as it develops from a single cell to an organism that is ready to be born or hatched. Embryology is often used to help understand the evolutionary history of an animal because embryonic development mimics evolutionary development. For example, human embryos have gills and a tail during one stage of their development. Isn't that weird?!!?

The early stages of embryo development are similar for many sexually reproducing animals. Animals as different as elephants and mice start out as groups of cells that look very much alike. Research into the ways these similar groups of cells develop into such a wide variety of organisms may provide us with valuable medical technology and insight into our evolutionary past.

In this activity, you will be observing the development of sea urchin embryos from fertilization until they develop into free swimming larvae.

Procedure

Sea urchins, like many other animals and plants, reproduce sexually. Special sex cells, called **gametes** combine to form a cell that contains genetic information from both parents. This cell is called a **zygote**. Once the zygote begins dividing it is called an embryo.

In order to proceed with this activity you will need sea urchin gametes (eggs and sperm). Your instructor will cause the sea urchins to release their gametes by injecting them with potassium chloride.

1. Examine a sea urchin. You will not be able to tell male and female sea urchins apart by looking at them. The females will release granular strands of yellow or red fluid containing eggs. The males release a milky white fluid containing sperm.

Your instructor will have collected the gametes and suspended them in seawater. Why is it important that they be in seawater instead of freshwater?

Now that you have the egg and sperm suspensions, you are ready to fertilize the sea urchin eggs.

2. With a medicine dropper, place 2-3 drops of egg suspension in the well of a depression slide.
3. Observe the eggs under the compound microscope on low and high power. Leave the microscope focused on one of the eggs with the high power objective.



Integrated Activity Idea

New technology enables scientists to determine many qualities of an embryo before it is even born. What benefits will this technology have? Why will it need to be carefully regulated?



Integrated Activity Idea

Photograph using a 35 mm or videotape format through a microscope the process of cell division. See the science department for equipment.

4. Place 1 drop of sperm suspension in the depression slide containing the eggs. On high power, observe the sperm cells.
5. When a sperm fertilizes an egg, a **fertilization membrane** forms around the egg to keep any other sperm from entering. Look for the fertilization membrane forming a "halo" around the fertilized eggs in your sample. What would happen if more than one sperm was allowed to fertilize a single egg?
6. Remove your slide from the microscope, write your name on it with a grease pencil, and store in a moist, cool place.
7. Over the next 24 hours, your embryo will go through several stages of development. In order to see these stages, return to the lab every few hours to check on your embryo, or look at embryos started during different class periods. As the embryo grows larger, observe it with the low power objective lens.



Integrated Activity Idea

Embryo cells divide at an exponential rate. If the 1st cell begins dividing at a rate of 1 cleavage every five minutes, how many cells will the embryo have after 1 hour?

Stages of Embryo Development

1. **2-celled stage or first cleavage:** occurs 60-70 minutes after fertilization.

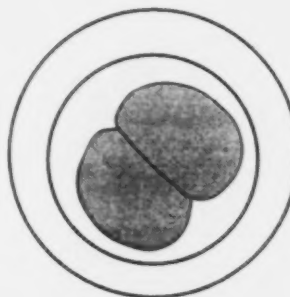


Figure 7 - First Cleavage

2. **4-celled stage or second cleavage:** occurs 80-100 minutes after fertilization.

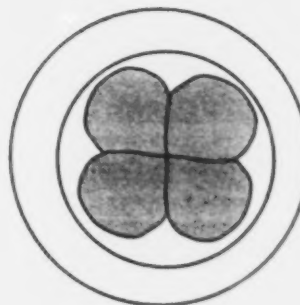


Figure 8 - Second Cleavage



Integrated Activity Idea

Draw each stage of sea urchin development that you observe.



3. **8-celled stage or third cleavage:** occurs 103 minutes after fertilization. Note that the number of cells doubles with each cleavage. Also note that although the cells are increasing in number, the individual cells are becoming smaller. The total size of the embryo is no larger than the egg was.

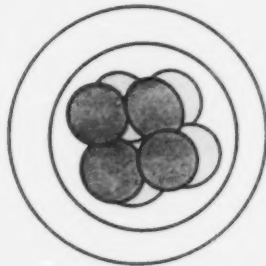


Figure 9 - Third Cleavage

4. **Blastula:** occurs 7-8 hours after fertilization. The blastula is a hollow ball formed of many small cells.

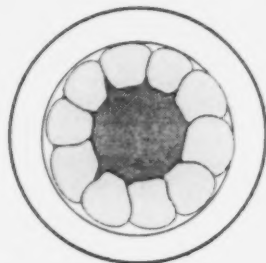


Figure 10 - Blastula

5. **Gastrula:** occurs 12-15 hours after fertilization. During gastrulation, part of the wall of the blastula folds inward. The cells lining the pocket that has formed inside the embryo will become the lining of the digestive tract. The outer cell layer will develop into the body wall, glands and nervous system.

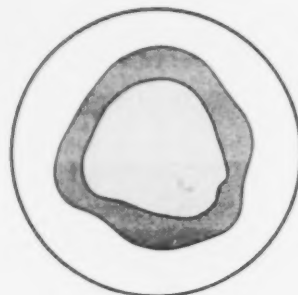


Figure 11 - Gastrula

6. **Pluteus:** occurs after 24 hours. The pluteus is the free-swimming larval form of the sea urchin.



Figure 12 - Pluteus

Try to observe as many of these stages as possible. If they are available, examine prepared slides of sea urchin development.

Adapted from Scott, Foresman *Biology Laboratory Manual* (1985) Scott, Foresman and Company. pp. 239-242 and Miller, Stephen A. (1994) General Zoology Laboratory Manual Wm. C. Brown Publishers. pp. 65-74.

Materials Needed

Sea urchins	Stirring rod
150 ml beakers	medicine dropper and bottle
Seawater	Depression slides
Syringe	4% KCl solution
Compound microscope	Grease pencil
100-ml graduated cylinder	Clock

(Sea urchin kits are available from Pacific Biomarine Laboratories, P.O. Box 1348, Venice CA 90294)



Activity 9

Medical Technology

One of the most complicated machines in the world is the human body. Technology has definitely affected us as humans in many ways, but perhaps the most direct impact on human existence has been the growth of technologically advanced diagnostic and surgical equipment. The following activities will help the student better understand the central nervous system and some of the diseases that effect it. Students should also develop an understanding of medical procedures and technological advancements that have led to accurate diagnosis of neurological disorders.



Integrated Activity Idea

Shadow a health care professional to see whether you might be interested in a health occupations related career.

Software Preparation For The Student

1. Open the software titled "Life and Death II". This software is a simulation of what life is like as a neurologist. The first thing that appears after opening the software is a sign in sheet on a clipboard.
2. Type your name on a blank line, or select a name from the list. If you type your name in, it will ask you to report to the classroom. The classroom is at the bottom left corner of the screen. Use the mouse to position the cursor in the classroom and click the left mouse button. Pay attention while in class, the first lesson will tell you how to navigate through the hospital.
3. After getting the orientation lecture, ignore the message that you have a patient and explore the different rooms of the hospital. While exploring, you will want to look for the built-in instructional aids the software gives you. In the classroom, the overhead has a list of topics. By clicking on the topic you want to know about you can find the procedures for doing anything you want to do as a doctor in the hospital. You will also have a Neurology Book available to you which describes neurological disorders, their symptoms, and how to treat them. To be successful you will have to make full use of these instructional aids.
4. Answer the questions below. The answers can be found by clicking on the diagnostic rooms that show up at the top of the hospital floor plan in "Life and Death II".
 - Describe what happens to a person who undergoes an angiogram.
 - What equipment is used to do an angiogram?
 - What is an MRI scan, and how does it work?
 - What is a CAT scan and how is it used to diagnose a patient's problem?
 - Describe the procedure for conducting a skull X-Ray.

5. Sketch what an MRI scan of each disorder would look like in the appropriately labeled box.

Normal	Subdural Hematoma
Aneurysm	Infarction



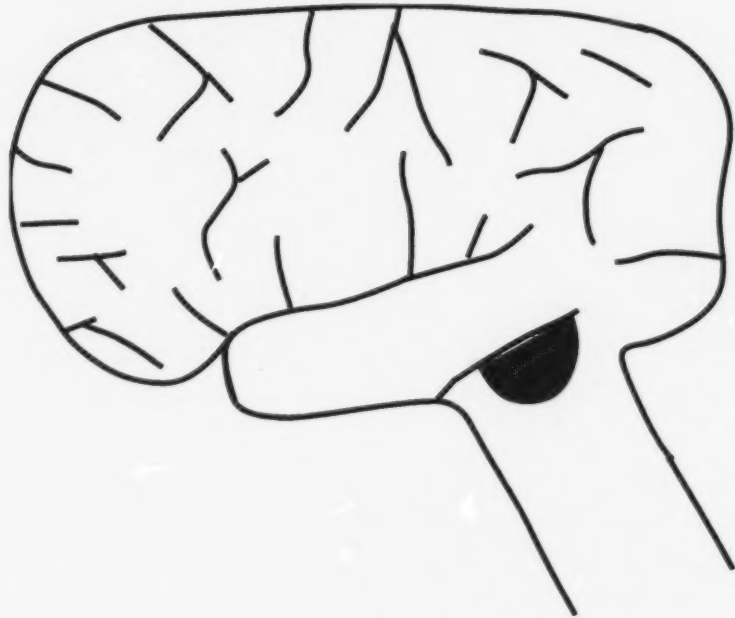
**Integrated
Activity Idea**

Conduct a debate on the pros and cons of modern medical technology. In what ways has technology improved the quality of life? In what ways has it eroded the quality of life?



6. Next, you will need to gather some more information about various brain disorders. Even good physicians must keep learning. Using the software, click on the icon which represents a book of "neurological terms." After reading through it, answer the following questions. (Answers to the questions below can be found in the Neurology Book provided in the Life and Death Software.)
- What disease is caused by the enlargement of the artery?
 - a) Aneurysm
 - b) Brain tumor
 - c) Subdural hematoma
 - d) Infarction
 - What disease is caused by abnormal formation of tissue?
 - a) Aneurysm
 - b) Brain tumor
 - c) Subdural hematoma
 - d) Infarction
 - Which one of the following diseases does NOT require surgery?
 - a) Aneurysm
 - b) Brain tumor
 - c) Subdural hematoma
 - d) Infarction
 - If a patient suffers from slurred speech, which one of the following diseases may he or she have?
 - a) Aneurysm
 - b) Brain tumor
 - c) Hysteria
 - d) Neuropathy
 - Which one of the following diseases may be treated with codeine?
 - a) Aneurysm
 - b) Migraines
 - c) Hysteria
 - d) Infarction
 - Another name for infarction is
 - a) Migraines
 - b) Aneurysm
 - c) Stroke
 - d) Hysteria
 - Damage to the left side of the brain may impair speech.
 - a) True
 - b) False
 - Which one of the following diseases requires treatment by a psychiatrist?
 - a) Aneurysm
 - b) Migraines
 - c) Hysteria
 - d) Infarction
 - Administering a CAT scan is appropriate for the following diseases except:
 - a) Subdural hematoma
 - b) Brain tumor
 - c) Neuropathy
 - d) Infarction
 - Brain tumors are caused by :
 - a) High anxiety
 - b) Blocked blood vessels
 - c) Severe headaches
 - d) Abnormal formation of tissue

7. Using the neurology book provided in the software as a reference, label the diagram of the head below. There should be eight parts in your answer.



8. Now that you are familiar with the software instructional aids, and have some knowledge of the diagnostic equipment, procedures, and the central nervous system, you are ready to simulate life as a neurologist by diagnosing and treating patients. While working through the game simulation remember to use the following instructional aids.
- The list of lectures on procedure that can be obtained by clicking on the overhead in the classroom at the hospital.
 - The "Neurology Book" that is usually on the screen while you are working with the patient. This will give you information on each disorder and its symptoms.

Materials Needed

Life and Death II software is available from: "The Software Toolworks"
60 Leveroni Court
Novato, CA 94949
1-800-234-3088

System Requirements: IBM Compatible 286 or faster, 2MB Ram and a VGA Monitor



Assessment

Scoring Rubric Activity 2 - Recycling Paper

Performance Standard	Wgt %	Exemplary 2 pts.	Acceptable 1 pt.	Not Yet Acceptable 0 pts.	Sub total
I. Creative Thinker					
Speculate the future of various areas of biotechnology, including those related to human gene alteration, foods development (plant and animal), population control, and disease prevention.	x1	Student performs literature search on future of paper recycling and locates 3 sources that meet preset literature criteria.	Student performs literature search on futures of paper recycling and locates 1 source that meets preset literature criteria.	Student does not locate any sources that meet preset literature criteria.	2 x 1 = 2
Identify typical applications in which biotechnology is effectively used in applications such as medicine, environmental control, and foods development.	x1	Student gathers data regarding tree use / paper consumption / recycling and reports findings in oral and written media.	Student gathers data regarding tree use / paper consumption / recycling and reports findings in oral or written methods.	Student does not gather data and does not report findings.	2 x 1 = 2
II. Critical Thinker					
Describe how biotechnology relates to other areas of technology.	x.5	Student correctly ties bio-technology to the 3 technology clusters with no errors.	Students correctly ties bio-technology to 1 of the 3 technology clusters with no errors.	Student does not correctly tie bio-technology to any of the 3 technology clusters.	2 x .5 = 1
Recognize and analyze the potential positive and negative impacts of the increased use of biotechnology on society.	x.5	Student correctly recognizes and analyzes the positive and negative impacts of paper recycling (per class discussions) with no errors.	Student correctly recognizes and analyzes the positive impacts of paper recycling (per class discussions) with no errors.	Student does not correctly analyze the positive or negative impacts of paper recycling (per class discussions).	2 x .5 = 1
III. Contributing Citizen					
Practice all safety and ethical procedures when constructing biotechnology projects.	x1	Student practices all safety/ethical procedures at all times and encourages others to do so.	Student practices all safety/ethical procedures of the recycling paper activity at all times.	Student does not practice all safety/ethical procedures at all times.	2 x 1 = 2
IV. Self-Directed Learner					
Identify career options and foundation skills involved in pursuing a career in biotechnology.	x.5	Student sponsors a bio-tech speaker for a class "career day" and activity participates in event.	Student actively participates in a class bio-tech "career day" (convenes, pays attention, etc.).	Student does not actively participate in a class bio-tech "career day".	2 x .5 = 1
V. Problem Solver					
Develop a design for and solve problems related to constructing a simple biotechnology project or experiment.	x1	Student successfully develops and solves problems for paper recycling project with limited assistance from others (less than 3 situations).	Student successfully develops and solves problems for paper recycling project with average assistance from others (3-5 situations).	Student does not successfully develop/ solve problems for project and/or requires excessive assistance from others.	2 x 1 = 2
VI. Effective Communicator					
Communicate orally, visually, and/or in writing the principles included in the design and construction of a biotechnology project or experiment.	x2	Student successfully completes and orally presents to the class a written assignment describing the principles of the project.	Student successfully completes a written assignment describing the principles of the paper recycling project.	Student does not successfully complete (per preset criteria) a written assignment describing the principles of the project.	2 x 2 = 4
VII. Quality Producer					
Demonstrate the proper care of and ability to work with highly specialized laboratory equipment.	x2	Student properly works with all equipment and encourages others to do so.	Student properly works with all paper recycling equipment.	Student does not always properly work with all paper recycling equipment.	2 x 2 = 4
VIII. Technical Foundations					
Define those practices and terms used in biotechnology, including bio-mass, gene splicing, bio-degrading, and hydroponics.	x.5	Student achieves a 90% mastery rate on paper recycling written examination.	Student achieves a 70% mastery rate on paper recycling written examination.	Student achieves less than 70% mastery rate on paper recycling written examination.	2 x .5 = 1

Total: 20 out of 20 possible

Assessment Debriefing

Complete the debriefing questions which are located at the conclusion of most of the TAM's activities.

Performance Checklist for Activity 5 - Toxicity Testing

- 4 = Excellent** (student successfully completes activity & displays mastery of subject/content)
- 3 = Good** (student completes activity with good quality)
- 2 = Needs Improvement** (student completes activity without demonstrating mastery of subject matter or activity performance requirements)
- 1 = Not Acceptable** (student does not yet successfully complete the activity, needs additional work)

1. Student successfully prepares 2 liter soda bottles (cut to proper height, proper number of bottles, cleaned, etc.). ..	4	3	2	1
2. Student properly fills soda containers with water and makes an accurate column measurement.	4	3	2	1
3. Student correctly mixes a variety of toxins to the proper ratio. Student also mixes 3 identical samples for each toxin	4	3	2	1
4. Student properly codes samples to reduce bias errors.	4	3	2	1
5. Student develops hypotheses prior to placing duckweed into various solutions.	4	3	2	1
6. Student properly places 12 duckweeds into each container.	4	3	2	1
7. Student is consistent with observation intervals and correctly records results.	4	3	2	1
8. All samples are held consistent with each other, including temperature, slow evaporation, and standardized light exposure.	4	3	2	1
9. Student successfully completes all objectives and compares results to hypothesized outcomes.	4	3	2	1
10. Student completes an appropriate technical report which properly documents the results of the experiment.	4	3	2	1



Additional Focus Questions

1. In a brief paragraph describe what makes bio-related technology different from biology. _____

2. Name and describe 5 examples of products which are the result of bio-technology research. _____

3. Identify and discuss 3 key issues related to the use of bio-related technology. Consider both animal and human life. _____

4. Attempt to propel your thinking to the year 2020. What are some of the ways in which bio-technology might be in use by then. Will these developments be positive or negative? Explain. _____

5. Bio-related technology has been identified by many in the profession as our newest area of study. What do you think? Should bio-related technology be included in the content of Technology Education. Justify your answer. _____

Bio-related Technology TechFolio

Develop a bio-related technology TechFolio. Among the items which could be included are:

- Written responses to discussion and follow-up questions included in the TAM's activities.
- Charts and graphs documenting the results of the activity experiments (toxicity, gravitropism, filtration, etc.)
- Technical report write ups on the activities in the TAM
- Clips from newspapers and magazines on bio-related technology news (like the Flavor Savor tomato or high production milk cows).
- A brainstorm generated list of spin-off ideas for future bio-related technology applications.
- Other

Note: See page 82 in the Performance Standards Education Implementation Handbook for a sample TechFolio scoring procedure.



By Drew Charles, Marcia Kelly Nelson & Tom Trewyn

Instructor Resource

Technology & The Living World

Content Outline

1. Definitions & Basic Concepts

2. Genetic Engineering

- Plant
- Animal
- Human
- Issues

3. Environmental Issues

- Recycling
- Ozone Depletion
- Fossil Fuel Use
- Pollution
- Deforestation

4. Bio-related Energy Sources

5. Bio-related Energy Production

- Gasification
- Direct Combustion
- Cogeneration
- Biological Conversion
- Waste to Energy Systems
- Crop to Energy Systems

6. Careers

Instructional Resources

Books

Oak Ridge Associated Universities (1981). Biomass I - Science Related Activities in Energy. Oak Ridge, TN: The American Museum of Science and Energy.

Sunset Books. (1973). Terrariums and Miniature Gardens Lane Magazine and Book Co., 1973.

Scott, Foresman (1985) Biology Laboratory Manual Scott, Foresman and Company. pp. 239-242.

Miller, Stephen A. (1994) General Zoology Laboratory Manual Wm. C. Brown Publishers. pp. 65-74.

Finke, G. D.; Rossner, A. G. & Savage, E. N. (1993) Bio-Related Technology. Delmar. pp. 73-110.

Markovits, Paul S. (1990). Biotechnology: Unit for secondary students. Monsanto Fund and National Science Foundation. The Biotechnology Education Project, St. Louis: St. Louis Mathematics and Science Education Center.

Micklos, David A., & Freyer, Greg A. A First Course in recombinant DNA Technology.

Kyte, Lydiane. Plants form Test Tubes. Portland, OR: Timber Press.

Magazines

Editors. (1989, December). Hazardous Waste Disposal. The Technology Teacher. p. 19. (Lots of good information on hazardous waste including a historical perspective, social and cultural impact, relationship to biotechnology and genetic engineering.)

Staff. (1990, April 20) Earth Day 1990. USA Today, sections E and F. (Information on biotechnology, recycling, impact of technology on living world.)

Paschal, John S. (1988, Spring) Carolina Chemtips. IV. (Polyvinyl alcohol.)

Powell, Cory S. (1990, August) Plastic Goes Green. Scientific American. p. 101. (Good article on career potential in recycling.)



Oppenheimer, Steven B., (September 1989) The Sea Urchin Embryo: A Remarkable Classroom Tool. *The American Biology Teacher*, 51, 354-357.

Igelsrud, Don, (October 1987) Sea Urchins. *The American Biology Teacher*, 49, 446-450.

Films/Video

To Do Science is to Know Science: My Life as a Scientist, National Institute of Health, Office of Education.

Biotechnology: Careers for the 21st Century, NABT

Research: The Ultimate Adventure, The American Society for Pharmacology

Of the Earth, Monsanto Corporation

Plants, Animals, and People, Science Screen Report, Issue number 7/8.

Nature of Change, Monsanto Corporation

Audiovisual Education Department of the Cooperating School Districts of the St. Louis Suburban Area, Inc.

Software

DNA: The Master Molecule, Educational Materials and Equipment Co., 1985.

Life and Death II, The Software Toolworks, 60 Leveroni Court, Novato, CA 94949. 1-800-234-3088.

Glossary of Terms

Anaerobic digestion - the application of microorganisms to biomass material in an oxygen-reduced tank.

Anaerobic treatment - a sewage treatment process that uses bacteria that do not require oxygen to break down organic wastes into nutrients and methane gas.

Aneurysm - enlargement in artery caused by a weak arterial wall.

Aqua culture - cultivation of plants and animals in a water environment for food production.

Biodegradable - a product that can break down into a soil-like material naturally.

Biomass - all organic matter that has been produced by photosynthesis.

Biotechnology - the use of biological tools to solve technical problems.

Biosphere - a totally self contained living atmosphere that is self supporting and can support human life.

Blastula - stage of embryo development consisting of a hollow ball of small cells.

Cleavage - division of the cells of an embryo.

Cloning - the practice of producing a genetically identical living thing; generally accomplished by using tissue or a genetic sample from the original.

Dura mater - a tough fibrous membrane that covers the brain and the spinal cord.

Embryo - an animal in stages of development preceding birth or hatching.

Embryology - the branch of biology dealing with embryos and their development.

Ergonomics - the design of equipment or devices to fit the human body's movement and environment.

Fertilization - the union of two gametes to produce a zygote.

Fertilization membrane - a protective membrane that forms around an egg after fertilization to prevent additional sperm from entering.

Filtration - the process of passing a fluid through porous material to remove unwanted solids, particles or impurities. Filtration does not usually purify the liquid.

Gametes - sex cells, such as eggs and sperm that unite to form a new animal or plant.

Gastrula - stage of embryo development in which the embryo wall has folded inward to form an inner cavity.

Genetic engineering - a technological field that involves splicing different pieces of genetic information together to form new genetic codes of sequences.

Global warming - gradual heating of the planet.

Greenhouse effect - trapping of the heat in the atmosphere, causing global warming.

Hazardous Waste - any waste product that will endanger the earth's natural processes.

Hydroponics - cultivation of plants in water containing dissolved inorganic nutrients, rather than in soil.

Infarction - blockage of blood vessels outside the vessel walls.

Parent plant - the donor plant; the plant tissue taken from for tissue culturing.

Planula - free-swimming larval form of sea urchin.

Photosynthesis - the combination of water and carbon dioxide and sunshine in green plants which causes the formation of sugars and starches.

Propagate - to cause plants or animals to reproduce.

Pulp - the soft mushy mass of water and paper used to make fresh recycled paper.

Purification - (As related to this TAM) the process of removing or neutralizing any contaminants in a fluid that can be harmful.

Rain cycle - the cycle of continuous process of moisture and vapor being released into the atmosphere and returning to the ground as rain.

Sanitary landfill - a solid waste disposal site located away from ground water and surface water. Its operation involves covering the waste periodically with layers of dirt to limit air pollution, disease, and rodent infestation. Burning is not permitted and air and water pollution are reduced.

Terrarium - a controlled atmosphere for the growth of plants.

Tissue culturing - the practice of using a specific piece of tissue from one plant to modify or reproduce another.

Water soluble - able to dissolve in water.

Zygote - a fertilized egg before its first cleavage.

Safety Factors

- Caution should be used with filtered water and contaminants.
- Care should be taken when working with microscopes. Be sure to handle them carefully, they are expensive. Seawater is corrosive and should be cleaned off immediately if it comes in contact with the microscopes.
- Be careful when working with methane gas.



Instructional Suggestions

Motivation

- Have a guest speaker from the city address recycling needs, problems with disposal of hazardous waste and landfill concerns.
- Visit a greenhouse or have a permanent terrarium in your room.
- Have a class discussion of the Biosphere II experiment.
- Have a class discussion about what our lives might be like if we don't change.

Prerequisite Information

- A general knowledge of biology.
- Basic knowledge of genetics.
- Basic computer operation.

Demonstrations

- How to put growing medium into terrarium
- Process of putting plants into the terrarium
- The entire process of recycling paper in Activity 2, depending on the age of the students
- Express the importance of being very clean with genetic engineering. Do as little damage as possible to your sample.
- Use and care of microscopes and slides
- Methods of handling samples of live cells
- Demonstrate the technique for inducing sea urchins to shed gametes.
- Demonstrate how to navigate through the Life and Death II software.

Academic Enrichment

- Shadow a physician.
- Shadow a research biologist.
- Additional in depth study of related biology and chemistry topics.

Related TAMS

- 1991 Implementation Workshop Series
Tam 19 Bio-Technology: A materials and Processes Approach

Assessment/Evaluation Suggestions

- Develop a list of lab procedures adapted to your needs. Procedure will be all important in these activities.
- Knowledge of terms will be important for communication purposes. Choose from the list to suit your needs.
- Have your students research and discuss the pros and cons of biotechnology and genetic engineering.
- Have students brainstorm for water soluble plastics uses.

- Have students brainstorm ideas for genetic engineering.
- Have students brainstorm ideas for solutions to hazardous waste disposal.
- Evaluate students on their critical thinking skills, particularly in areas dealing with important ethical issues and dilemmas.

Note: Review the assessment items which are presented throughout the Performance Standards TAMS for ideas which can be adapted for this TAM. You should also refer to the Performance Standards Implementation Handbook for additional assessment examples and ideas.

Summary

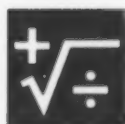
Biotechnology touches every technological field in some way. We have just scratched the surface of what we can do. Biotechnology will continue to grow and expand with new products and developments to improve our lives. The career possibilities are endless.



Smart Houses

Goal

At no other time in modern history has technology changed so fast as has occurred over the last 25 years. The goal of this TAM is to provide the student with basic knowledge, hands on experience, and basic procedures to turn any home into a smart house.



Mathematics



Communications



Science



Social Studies



Fine Arts



Health



Technology

Performance Standards

- Speculate the future uses of smart houses.
- Comprehend how smart house technology impacts and affects society and the everyday lives of its citizens.
- Practice all safety procedures when planning, designing, developing and interacting with smart houses.
- Know sources to use in gathering information about smart home devices to intelligently select and purchase automated home systems (including vendors, contractors, magazines, books, etc.).
- Develop a design for and solve problems related to constructing a simple smart house.
- Communicate orally, visually, and/or in writing the principles of control and feedback used in smart houses.
- Perform procedures involved in assembling and constructing electrical devices for use in automated homes.
- Develop basic competency in the use of control systems for automated home systems.
- Understand the function of basic electronic components involved in constructing home security devices.
- Name and describe the function of the various components which are included in an automated home system (e.g. sensors, devices for input, systems control, output, etc.).



Introduction

Picture yourself in a home, in which every weekday morning, the heat automatically comes up, the bedroom lights come up to only 20 percent brightness, you wake to your favorite radio station which is playing over the sound system. The bathroom lights turn on, the shower comes on and adjusts to a preset temperature. The tea or coffee begins to brew. The security system shuts down and the yard light shuts off as well. Your home has just completed the awake mode.

You and your spouse leave for work and the children head to school. As you leave you touch another button and put the house into the unoccupied mode. The home security system is armed, power to the kitchen (where you may have left the coffee pot on) is interrupted, and the thermostat on your electric heating and cooling system automatically sets itself to a lower or higher temperature depending on the season. Later that afternoon the thermostat again adjusts the temperature in the home, waiting for your arrival.

Imagine just as you climb into bed, you have forgotten to turn off some lights. No problem. At a preset time your home will go into the asleep mode. In this mode, all lights will be turned off; the security system will be armed; yard lights will be turned on; and the thermostat will be lowered. In any of the modes, the home can be monitored from your system for situations ranging from fires to burglars. In the case of fire, the system's sensors can automatically call the fire department and tell them where in the home the fire is located, and what rooms are being occupied by individuals. The same applies to security. If a zone has been interrupted, the system will automatically call the proper authorities.

Can all these comforts of a home be taken care of for you by the house itself? Sound impossible? Well, not to a smart house with the proper electronics and technology.

What is a smart house? Smart houses were developed by the National Home Builders Association in 1984. They wanted to develop an automated home management system with all functions in the home tied together. They wanted something exciting for the 1990's. Smart house by definition is a one for all wiring harness linking all appliances and systems (light, heating/air condition, plumbing), plus microprocessors that call the shots after they have been programmed by the owner. Implications are mind boggling because integrated home automation assumes that everything electrical can communicate with and control everything else. This will result in a smart house that will bring improved safety, better security, greater convenience, improved comfort, better communications, and reduced energy costs.

How does the smart house work? The smart house or home automation is controlled by the Systems Controller. The Systems Controller is able to transmit and receive signals from attached products and appliances. You can also manage a smart house by telephone, hand held remotes, key pads, and voice commands. All communication is done through the house wiring. Senders communicate with receivers in one of two ways. The first method uses the house

wiring with remote controllers that will send low voltage signals through the wiring. The second method uses controllers that communicate by infrared light. The only problem here is that the sender must be in direct line of sight with the receiver. Relay stations or mirrors can be used to help relay the light beam.

So you see the cables, connectors, and convenience centers might be called the nervous system of the smart house, with the system controller acting as the brain. Incoming commands are entered from around the home through the devices already mentioned. These commands are translated into a single, common language and routed through the system controller which then passes the command through the wiring to the appropriate appliance, product or convenience centers.

The complete house of the future will be programmable to set up to eight different modes: awake, asleep, unoccupied, automatic, and vacation, plus three optional modes you can select according to your lifestyle. You could say that your smart house might actually have a life all of its own.

Objective Statement

The activities described in the following pages represent samples of activities which can be used to deliver these performance standards. Many additional activities can and should be used. Extreme care should be taken to connect each activity with appropriate activity objectives as well as with the performance standards listed on page 1. These objectives should be developed by the instructor and should be shared with and made clear to the students.



Activity 1

Infrared Detector

Infrared light is a light that lies outside the visible spectrum at its red end. The infrared detector is a device that detects most types of invisible infrared waves using a simple sensor. In the circuit you will build, it uses a sensitive PN type solar sensor that is specifically designed for light energy. This sensor is connected directly to a Darlington amp made up of PNP transistors. Biasing is provided by resistors and transistors, with a variable resistor and another transistor serving as a sensitivity control. The collector lead of another transistor is the output lead of the Darlington amp, and it is connected to a red LED and the primary of the transformer. The function of the white dot transformer is to convert the low voltage output signal to a high enough level to drive a small piezo disc. This disc will make a clicking sound when the sensor picks up an infrared signal that is varying in frequency or amplitude.

After finishing this simple circuit, you will be able to detect the infrared light source being given off from remote controls (TV, stereo, VCR, etc.). You will also be able to explain or see how the units such as TV or VCRs pick up the signals and begin to interpret them into commands.

Procedure

1. Obtain the parts for the project or purchase a kit. Use 60/40 rosin core solder only.

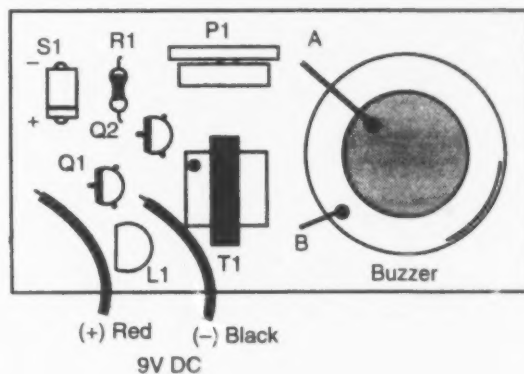


Figure 1 - Parts Layout

2. Assemble parts using the schematic.



Technology Idea

Design a super smart house. Include provisions for sensor regulated control of lighting, temperature, security, sanitation, lawn care, etc. Develop a CAD drawing which includes a layer especially for your smart house electronics. Develop a list of materials, devices, and suppliers needed including estimated costs.

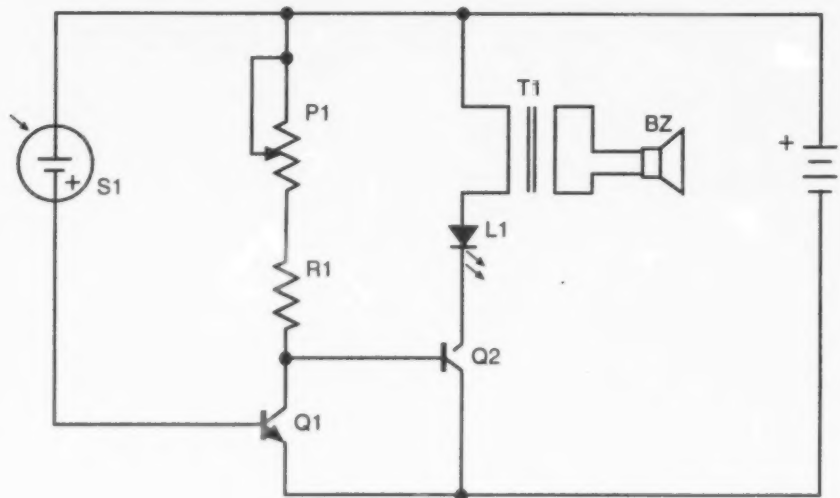


Figure 2 - Home Schematic

3. Install solar sensor S1 with colored lead (-) in direction shown. Install resistor R1 per color code and parts layout.
4. Observe flat side location of transistors Q1 and Q2 when installing. Install jumbo red LED L1 with flat side in direction shown.
5. Install trimmer resistor P1 and transformer T1 as shown. Observe polarity when installing 9V snap.
6. Install piezo disc BZ by first cutting the piece of bare wire in half and then install one end of each piece into the PC board. Lay BZ on the PC board in position shown; then carefully bend over pieces of bare wire and cut them to match layout. Now, solder each piece of bare wire to disc at point shown. Use only a small amount of solder, and try not to use excessive heat. Do not allow wire piece A to touch the brass disc.
7. After rechecking assembly for accuracy, connect a fresh 9V battery to snap. Set the kit so that the sensor does not face directly at any light source.
8. Adjust P1 until L1 just extinguishes.
9. Your infrared detector is now ready to test infrared controllers, infrared LEDs, etc.
10. Simply aim your controller at the sensor and press each button. You should notice that L1 will flash and BZ will emit a clicking sound.
11. To test infrared LEDs, bring the LED near the sensor and turn on and off the power source to your infrared LED. You should observe L1 flashing and BZ clicking at the rate you are turning the infrared on and off.



12. For longer range, place your infrared detector in a darkened room and P1 fully counterclockwise (L1 should be off in darkness). Now you can detect a good infrared controller at up to 10 ft. away, and sometimes greater depending on your controllers output power.

Materials Needed

Materials

1- Piezo disc
1-Jumbo red LED
1-50K trimmer resistor
1-2N3904 transistor
1-2N3906 transistor
1-270 ohm resistor
1-solar sensor
1-white dot transformer
pc board (Chaney Electronics)
9V snap
bare wire

Equipment

Pencil tip soldering gun
Wire strippers
60/40 rosin core solder
screwdrivers (standard and Phillips)
remote control unit from a VCR, or TV

Activity 2

Pressure Switch/Security Alarm



Integrated Activity Idea

Debate and discuss the forces in modern society which have created a need for security systems. What impact (other than safety) have these technologies had on our culture? Discuss the future trends related to security and the need for security. What is happening in our culture? Will technology help or hinder?

In this activity you will be producing a pressure switch that when wired with the correct circuit, can become a burglar/security alarm. This pressure switch uses an N channel FET (Field Effect Transistor) to electronically operate a relay for a set time period. This relay has its contacts wired to a loud metal horn which emits sound when the relay contacts operate. The FET has a high input impedance on its "gate" and a low resistance between the "drain" and "source" when it turns on. To turn the FET on you will need only to momentarily squeeze the plates on the pressure switch together. This action causes a positive voltage to be coupled from the battery to the gate of FET by way of the coupling resistor. This momentary positive is stored in a tantalum capacitor which holds the FET in the ON state until the tantalum cap discharges by way of the 33K resistor and the 5 meg trimmer resistor. The lower amount of resistance on the trimmer resistor, the faster the tantalum cap will discharge, causing the FET to turn off. With FET off the relay de-energizes, causing the horn to be silent.

Procedure

1. Obtain the parts for the project or purchase a kit. Use 60/40 rosin core solder only.

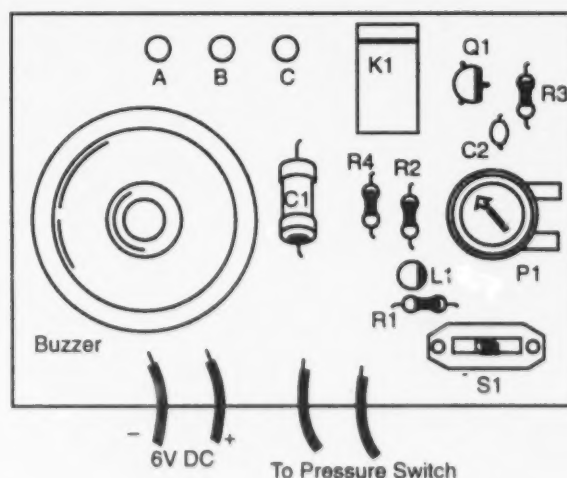


Figure 3 - Security Alarm

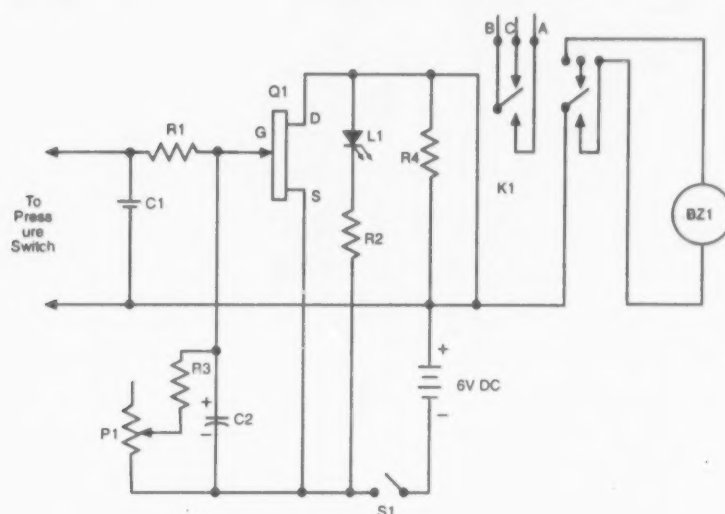


Figure 4 - Security Alarm

2. Install trimmer resistor P1 and relay K1 as shown.
3. Now install all resistors per color code, parts list and parts layout. Install capacitor C1 (no Polarity) and capacitor C2 (observing polarity).
4. Install FET transistor Q1 observing flat side location for correct mounting. Now install switch S1.
5. Install LED L1 observing cathode location (flat side of lens and shorter lead) shown by black half moon on parts layout.
6. Now install metal horn BZ1 as shown.
7. Solder two 6" long pieces of insulated wire to the battery input and connect your 2 wire cables that go from pressure switch to PC board. Do not connect the pressure switch yet.
8. To test the alarm, place S1 into off (center) position and connect the two 6" long power leads to a fresh 6V lantern battery. Now slide handle of S1 to either of the ON positions and the red LED L1 should light up but the unit should be silent. Now turn the knob on P1 full counter clockwise. Momentarily short together the wire leads that are to go to the pressure switch. The LED should go out and the horn should sound for several seconds. The circuit should then be silent and the red LED should light up again. Now rotate the knob approximately 1/2 turn clockwise. Momentarily short the pressure switch leads together again and the unit should sound for a much longer period of time then reset.

Pressure Switch Assembly

1. Take the 2 thin copper panels and lay them side by side with copper side facing up. Solder a pressure switch cable lead to lower left corner, on copper side of each panel.



Integrated Activity Idea

Conduct a study of what health professionals are saying about the effects of electromagnetic Fields (EMF) on human health. Develop a complete list of all electronic devices in your home. Surprised at how many of these there are? What are the implications for health? The environment? Energy consumption?



Integrated Activity Idea

Conduct a complete energy efficiency study of your home including R values of insulation, HVAC efficiency, door and window leakage, etc. Chart and graph your results. (See TAM 13 - Energy Audits in the Introduction to Energy and Power Technology Guide.)

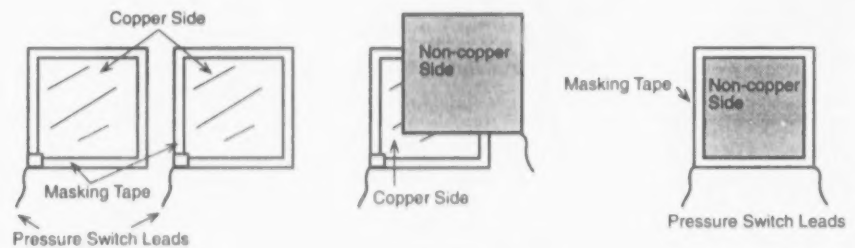


Figure 5 - Pressure Switch

2. Create a border on the copper side of each panel by placing masking tape along flush with all four sides of the panel. Place an extra piece of tape over the corner you soldered.
3. Now place panels together, with the taped, copper sides touching. Tape panels together around the edges with masking tape. There should be a pressure switch lead coming from two of four corners.
4. The pressure switch should be complete now and should be connected to the alarm board by way of the pressure switch cable leads. With the pressure switch connected to the circuit, move S1 to the ON position. The unit should remain silent. If it sounds, you have not constructed the pressure switch properly. Recheck pressure switch assembly steps. The circuit should sound off and then reset after the time period you have selected by control setting on P1.

After finishing this simple circuit you will be able to use this as a burglar/security system. To do this you will need to place this switch under a rug and place outside a door. Set the alarm and then walk on the rug to see if the alarm can be set off.

Materials Needed

Materials

1- Metal Horn	1- .1 uf Mylar cap
1- 33 uf Tantalum cap	1- 5 Meg trimmer resistor
1- DPDT 5V relay	1- Slide switch
1- Red LED	1- 39 ohm resistor
1- V11202FET	2- 100 ohm resistors
1- 33K resistor	1- 6V Lantern battery
pc board (Chaney Electronics)	
Wire	
copper pressure switch plates	

Equipment

Pencil tip soldering gun	Wire strippers
60/40 rosin core solder	Screwdrivers (standard, phillips)



Activity 3

Simulation Security Panel

Security panels are panels programed for different zones in a home or business. These zones can be individually set for security. Each zone may be set for entry/exit delay and when tampered with set off alarms.

In this activity you will use a pre-assembled alarm panel/keyboard and a LED flasher/control board. The LED flasher consists of 2 PNP transistors that are configured in a multivibrator type circuit design. At the initial application of power, the 2 PNP transistors are turned ON and the transistor is turned OFF. The transistor that is turned on, lights up a corresponding LED(s) on the panel that is connected through the ribbon cable to the collector of the transistor that is turned on. As the electrolytic capacitor 4.7 uf and 1 uf that is connected to the base charges up, it cuts off the transistor and the other transistor turns ON causing its corresponding LED(s) to light. The cycle repeats itself and is known as a multivibrator design.

The control circuit consists of SCR 2N5060, which functions to allow the multivibrator circuit to turn on and stay on when a key is pressed on the control panel. This happens because when the correct key (3, 6, or 9) is pushed, a positive bias is applied to the gate of the SCR. This positive bias latches the SCR ON causing current to flow through the current limiting circuit 3.6K resistor, 5K trimmer resistor, 150 ohm resistor through the alarm control panel ribbon cable and to the cathode of the alarm control panel LEDs. To unlatch or turn OFF the SCR, momentarily apply a positive bias to the cathode of the SCR by depressing the 0 or asterik key. The circuit does not draw current from the battery when the LEDs are off. The alarm control panel that has been provided is an actual control panel used on professional burglar/fire alarm systems and therefor provides a very realistic looking alarm.



Integrated Activity Idea

Conduct a historical study of early security devices. Attempt to locate those which are particularly interesting or unusual. What kinds of systems have been replaced by electronics systems?

Procedure

1. Obtain the parts for the project or purchase a kit. Use 60/40 rosin core solder only.

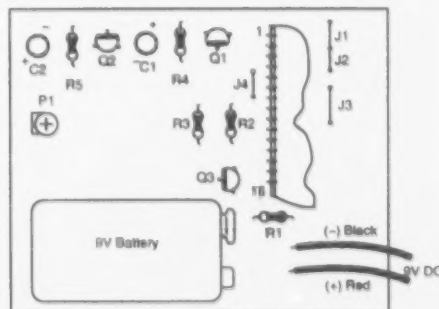


Figure 6 - Security Panel



Technology Idea

Develop a design for a smart room. Include automatic sound, light, and security control. Design the circuits using SPICE (or similar PC board layout program). Make the boards and wire your system. Alternatively, you can use devices purchased from electronics vendors.

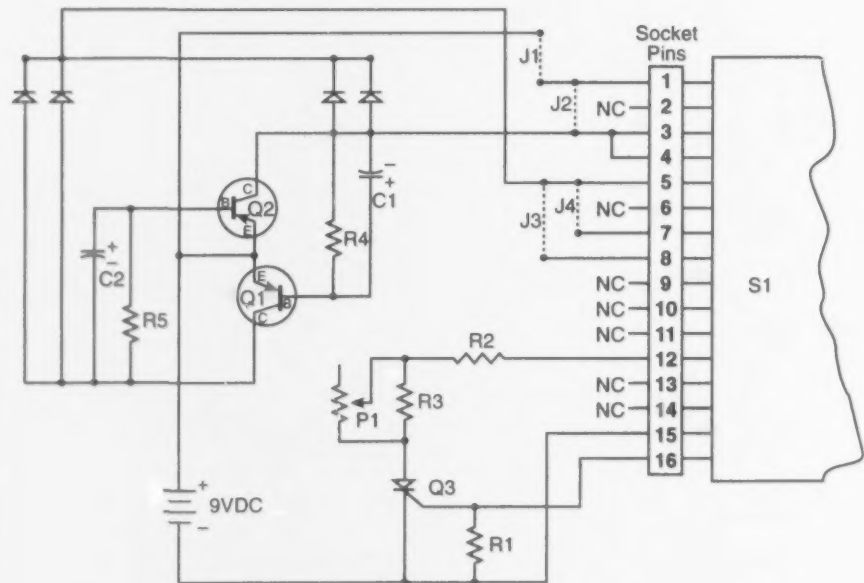


Figure 7 - Security Panel

2. Assemble parts using the schematic.
3. Install all resistors per color code (no polarity). Now install capacitors 4.7 uf and 1 uf observing polarity. Then install socket, no polarity.
4. Install transistors (2) 2N3906 PNP transistors and 2N5060 SCR observing flat side location for correct mounting.
5. Install 5K trimmer per parts layout. Now install battery snap observing color code polarity as shown.
6. Now you may select which LEDs you wish to flash or just stay on by installing the optional jumpers (figure 1). Use left over pieces of bare wire leads cut from the resistors and capacitors that you previously installed to make the jumpers. All table information assumes keyboard has been activated. You do not need to install jumpers if you don't want the LEDs listed in the table to operate.
7. After you have installed all the jumpers that you wish to install, carefully insert the alarm panel ribbon cable into the socket with the panel located face down.
8. Install a fresh 9V battery and then depress any of the following ON keys to activate your panel: 3, 6, 9.
9. Adjust the 5K trimmer resistor for desired brightness.
10. To turn OFF the panel, simply depress the asterik key or 0.



11. You may now use insulated wire to hold down the 9V battery.
12. Install the PC board to back of alarm panel using 3 screws provided.
13. Install panel in standard empty 4 outlet box or cut out a rectangular hole for mounting.
14. In actual use, remember to turn on your panel by pushing one of the On keys when you leave your house. Also remember to turn the unit off by pushing one of the OFF keys when you return to save the battery life.
15. In general, a burglar is not going to push buttons on your alarm panel because the burglar will see the words "silent alarm" printed on the panel. He/she will not know whether pushing the wrong key will alert the police.



Integrated Activity Idea

Discuss the home design and styling features which could be used to enhance security and energy efficiency and which could also accommodate electronic control devices.

Materials Needed

Materials

1- 4.7 uf Electrolytic capacitor
1- 47K Resistor
1- 1 uf Electrolytic capacitor
1- 150 ohm Resistor
1- 5K Trimmer resistor
1- 3.6K Resistor
2- 2N3906 PNP transistor
2- 100K Resistor
1- 2N5060 SCR
1- Alarm Panel
9v battery snap, 16 pin socket, mounting screws
PC board (Chaney Electronics)
insulated wire

Equipment

Pencil tip soldering gun
60/40 Rosin core solder
Wire strippers
Screwdriver (standard and phillips)



Technology Activity

Have the instructor give you a set of floor plans or draw your own. Now divide the plan into different zones. Use the security panel to activate the different zones in your home.

Activity 4

Door/Window Sensor Security

For security around any door or window a magnetic sensor can be used for protection. This can be accomplished using magnetic contact switches. When the magnetic sensor is tripped, the unit can send a signal back to a security console, or set off a beeper in the unit itself.



Integrated Activity Idea

Develop a list of factors which you think are impeding the development of smart houses. Brainstorm this as a class. Then look into the future 20 years, 50 years. Will the situation have changed? If so, what factors will have changed the degree of use? What will smart houses of tomorrow look like?

Procedure

1. First begin by making a scale model of a door or window section. This can be accomplished by using cardboard, wood, or styrofoam. You could also use a door or window in the lab if you have the Instructor's approval.

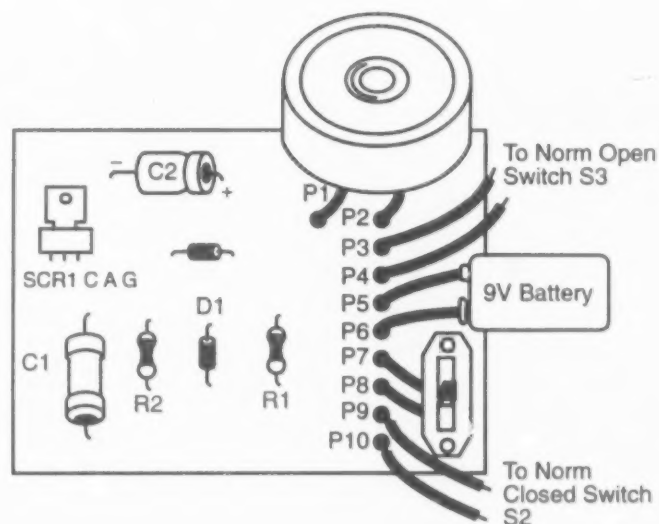


Figure 8 - Door/Window Sensor Security

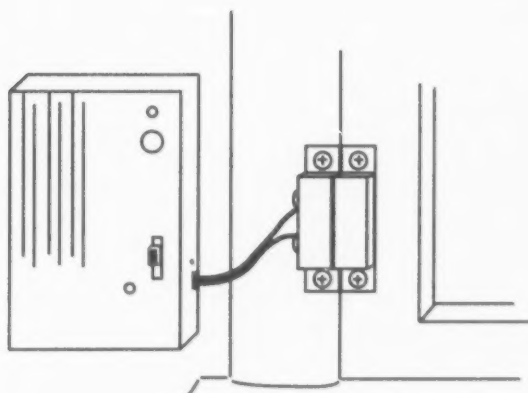


Figure 9 - Door/Window Sensor Security

2. After either building the scale model or using a door/window in the electronic device.

Steps in Building the Circuit

1. Pick up the circuit board and look at both sides. Notice that one side has metal traces. Mount all electronic parts on the side that does not have metal traces.

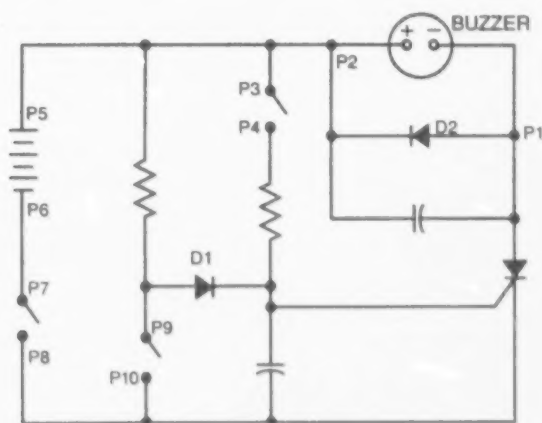


Figure 10 - Sensor Schematic

2. Identify R1 and R2, the 47K ohm resistors. Bend leads at right angles and solder them on the PC board in the position shown on the diagram.
3. Identify D1 and D2, the 1N4003 diodes. Bend leads at right angles and solder them to the PC board with the band at one end in the correct direction.



Technology Idea

Learn how to design, make and solder components to PC boards.



Integrated Activity Idea

Explore the health and safety considerations involved in using PC board making chemicals and in using solder. Identify and specify the cautions which should be taken.



Technology Idea

Contact your local electrical utility company for information they have about smart house technology. Most have pamphlets and other information which will give details about new technologies.



Integrated Activity Idea

Design and make a marketing video designed to sell customers on the value of smart house technology. (See Performance Standards TAM 7 - Video Technology by David Boyt for tips and techniques.)

4. Identify C1, the .1 uf capacitor. Solder C1 to the PC board.
5. Identify C2, the 30 to 50 uf capacitor. Solder C2 to the PC board with the negative and positive lead in the correct direction. (Capacitor will be marked on the negative lead).
6. Identify SCR, the C106B1 SCR. Solder it to the PC board with the beveled edge on the correct side and leave about 1/8-1/4 inch between the body of the SCR and the surface of the PC board.
7. Get four wires and install the wires for the alarm switches S2 and S3, as shown in the pictorial diagram. Solder them to the circuit board.
8. Identify A1, the buzzer. Solder two wires to its lugs and then solder the other end of these wires to the PC board as shown.
9. Identify B1, the battery snap. Strip 1/4 inch of insulation from the end of both wires. Install red wire in position P5 and the black wire in position P6.
10. Identify the switch S1. Solder two wires to its leads and then solder the other end of these wires to the PC board, as shown.

Materials Needed

Materials

- 1- 9V battery snap
- 1- buzzer
- 1- .1mfd. Capacitor
- 1- 47 mfd. Capacitor
- 2- 1N4003 Diode
- 2- 47K resistors
- 1- SPST Slide switch
- 1- SCR C106B1

misc.- pc board (Chaney Electronics), wood, styrofoam, cardboard for scale model (and any supplies to complete door or window)

Equipment

- Hammer
- Drill and Drill Bits
- Wood cutting tools
- Screwdrivers (standard and phillips)
- Glue
- Pencil tip soldering gun
- Wire strippers
- 60/40 rosin core solder



Activity 5

Smart House Wall Section

This activity is designed to give you basic principles to wire in smart house switches, and receptacles. After completion of wiring you will learn how to program these modules using a remote controller/timer. This remote will send signals through the wiring to any of the receivers (switches, outlets) to control lamps or appliances. You will learn how to set the switches and outlets to receive the signals from the controller and set up a program scene for your smart house wall section.



Integrated Activity Idea

Explore the various effects lighting of different types and levels has on the moods and well-being of people in their homes. How could this be altered automatically through smart house control and feedback systems?

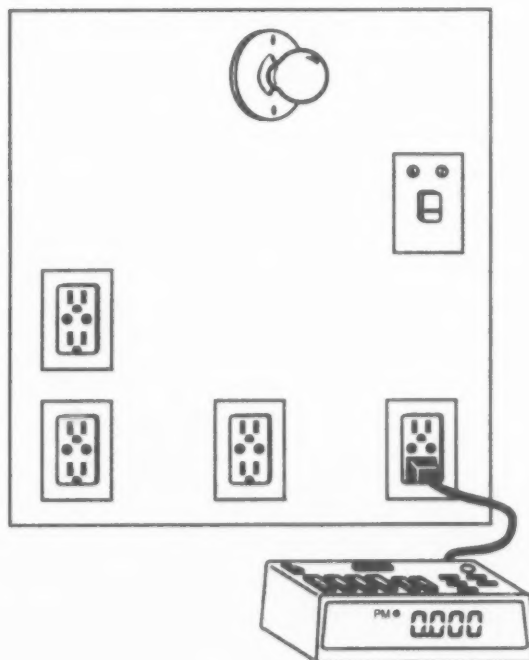


Figure 11 - Wall Section Layout

Procedure

1. Determine the size of the wall section to build. I used a 36" by 36" section to fit the four outlets, switch, and light to the panel.

2. Cut 2 x 4's to size and nail them together, testing for squareness. Place 1 stud at 16" on center in middle, which are standard measurements for industry.
3. Next drill a 1" hole through the center stud to allow electrical wire to pass through.
4. Fasten sheet rock (1/2") to the studs using sheet rock screws about 6" apart.
5. Determine where to place the junction box and receptacle boxes. Cut the opening in the sheet rock with a utility knife.
6. Nail the receptical boxes and junction box to the studs.
7. You are now ready to begin wiring. All boxes will share a common power source. Parallel wire all receptical boxes together. Allow enough wire to strip the ends.
8. Observing instructions, wire white to white, black to black, and ground to ground. Fasten wires together using the wire nuts.
9. Fasten recepticals into the outlet boxes.
10. Wire light switch to light using the smart house switch and observing wiring directions.

Programming

You are now ready to program the panel using the controller/timer. Your remote controller/timer sends out high-frequency signals through your household wiring system. The modules receive the controller's signals and turn the connected lights or appliances on or off.

1. **House Codes and Unit Codes** - two different types of codes, house codes and unit codes, allow you to control many different modules or groups of modules within you home. It is important that you understand how these codes are used before you set up your system.

The house code is the master code for a plug'n power system. You must set the controller/timer and all the modules it controls to the same house code. There are 16 house codes to choose from (A through P). You can operate two or more independent plug'n power systems in your home by using a different house code for each system. Of course, each system must have its own controller and modules.

For the unit codes in each plug'n, you can operate up to 16 different modules or groups of modules. Every module has a unit code dial with setting from 1 through 16. The controller lets you independently control each group of modules that you set for the same unit code.

2. **Setting up the Control Unit** - the Remote Controller/Timer controls the modules through your setting house wiring; setup of the controller is a snap. Plug the controller's AC cord into a convenient AC outlet. Then, set the house code dial to any one of the 16 house codes (A through



P). The switch and outlet modules require direct connection to your house wiring. Low voltage electricity flows through the circuit controlled by a switch module even when the switch is off.

3. **Setting the module's codes** - set the house code dials on all your modules to the same letter as your controller's house code dial (A through P). When setting the unit code dials, consider the following: All modules set to the same unit code respond as a group. If you have several modules controlling lights in a single room, set them to the same unit code.



Technology Idea

Brainstorm the possibilities of advances of computer technology for smart homes in the future. Consider such possibilities as fuzzy logic, voice activation, bio-computer interface, etc. Debate the positive and negative effects of your projections.

Materials Needed

Materials

- 1- Remote controller/timer
(Radio Shack)
- 1- Wall switch module (R.S.)
- 4- Wall outlet modules (R.S.)
- 5- Receptacle boxes (plastic or metal)
- 1- Junction box
- 1- Porcelaine light socket
- 25' of house wiring
- 1- Plug socket
- 2- 2 X 4 X 8'
- 1- 3' X 3' X 1/2" sheet rock
- 16 penny nails
- Sheet rock screws

Equipment

- Hammer
- Utility Knife
- Wire Stripper
- Screwdrivers (standard and phillips)
- Drill with Phillips head attachment
- Wood cutting tools
- Tape measure

Activity 6

Smart House Computer Control

In this activity you can use any existing floor plan or develop your own. If you are using the IBM compatible kit you will control up to 256 differently coded X-10 modules. With the windows version, you program "scenes". For example: the good morning scene could be to turn on the TV, the coffee pot, and bedside lamp. You could then program this scene to happen at 7:00 AM on weekdays only.

If you are using the Macintosh computers, it will let you draw your own background with MacPaint or use one of the backgrounds supplied. You install icons on the background to represent what you want to control. You then point and click to control up to 256 differently coded X-10 Modules. There's also a deck accessory which lets you control your home while working with another application.

Using Radio Shack's X-10 Home Control Interface you will be able to simulate an entire smart home control. The home control interface tells the Modules what to do. Command signals are sent over your existing house wiring to the Module or Modules of your choice. The modules respond to the command signals. You plug lamps into lamp modules, appliances into appliance modules, replace wall switches with wall switch modules and replace outlets with wall receptacle modules.

Just imagine, automate your home for the ultimate in comfort and security. Make your home look lived in by timing lights to turn on and off at preset times. Wake up to stereo music and fresh brewed coffee. Turn on low voltage appliances such as sprinklers and drapery controls. The interface sends signals over existing house wiring to control lights and appliances connected to modules.

Materials Needed

X-10 Home Control Interface, Model CP290P (Radio Shack)
X-10 Home Control Software
IBM PC, IBM Compatible, Mac
Monitor
9 Volt Alkaline Battery



Assessment

Scoring Rubric for Activity 5 - Smart House Wall Section

Performance Standards	Wgt %	Exemplary 2 pts.	Acceptable 1 pt.	Not Yet Acceptable 0 pts.	Sub total
I. Creative Thinker					
Speculate the futures of smart houses.	x.5	Student gathers and orally delivers 3 library sources on the future of smart houses.	Student gathers and orally delivers 1 library source on the future of smart houses.	Student does not gather and orally deliver any library sources on the future of smart houses.	2 x .5 = 1
II. Critical Thinker					
Comprehend how smart house technology impact and affect society and the everyday lives of its citizens.	x.5	Student writes a technical memo describing 3 ways a smart house would change (both pos. and neg.) their life.	Student writes a technical memo describing 1 way a smart house would change (both positively and negatively) their life.	Student does not write memo or does not meet preset criteria for writing technical memo.	2 x .5 = 1
III. Contributing Citizen					
Practice all safety procedures when planning, designing, developing, and interacting with smart houses.	x2	Student practices all safety procedures at all times.	Student practices all safety procedures but requires constant supervision.	Student does not always practice all safety procedures regardless of supervision level.	2 x 2 = 4
IV. Self-Directed Learner					
Know sources to use in gathering information about smart home devices to intelligently select and purchase automated home systems (including vendors, contractors, magazines, books, etc.)	x.5	Student writes a technical report about smart houses that addresses/meets all preset criteria with no errors.	Student writes a technical report about smart houses that addresses/meets all preset criteria with two or fewer errors.	Student writes a technical report about smart houses that does not address/meet all preset criteria and/or has more than two errors.	2 x .5 = 1
V. Problem Solver					
Develop a design for and solve problems related to constructing a simple smart house.	x1	Student develops own design for wall section and solves all problems with limited teacher interaction (less than 3 situations).	Student develops own design for wall section and solves all problems with standard teacher interaction (more than 3 situations).	Student requires constant supervision and assistance in designing and solving problems related to the wall section.	2 x 1 = 2
VI. Effective Communicator					
Communicate orally, visually, and/or in writing the principles of control and feedback used in smart houses.	x1.5	Student presents an oral report that correctly addresses all principles of control and feedback of the wall section components.	Student presents an oral report that addresses all principles of the wall section with 3 or fewer errors.	Students oral report does not address all principles and/or has more than 3 errors.	2 x 1.5 = 3
VII. Quality Producer					
Perform procedures involved in assembling and constructing electrical devices for use in automated homes.	x2	Student correctly constructs wall section activity per design criteria/specifications.	Student constructs wall section per design criteria with 2 or fewer errors.	Student constructs wall section per design criteria with more than 2 errors.	2 x 2 = 4
Develop basic competency in the use of control systems for automated home systems.	x1	Student displays 100% mastery of the components of the wall section exercise.	Student displays 70% or above mastery of the components of the wall section exercise.	Student displays less than 70% mastery of the components of the wall section exercise.	2 x 1 = 2
VIII. Technical Foundations					
Understand the function of basic electronic components involved in constructing home security devices.	x.5	Student achieves 90% mastery on a component-based written examination.	Student achieves 70% mastery on a component-based written examination.	Student achieves less than 70% mastery on a component-based written examination.	2 x .5 = 1
Name and describe the function of the various components which are included in an automated home system (e.g., sensors, devices for input, systems control, output, etc.)	x.5	Student achieves 90% mastery on a component-based written examination.	Student achieves 70% mastery on a component-based written examination.	Student achieves less than 70% mastery on a component-based written examination.	2 x .5 = 1

Total: 20 out of 20 Possible

PC Board Assembly Assessment

- 4 = Excellent (student successfully completes activity & displays mastery of subject/content)**
- 3 = Good (student completes activity with good quality)**
- 2 = Needs Improvement (student completes activity without demonstrating mastery of subject matter or activity performance requirements)**
- 1 = Not Acceptable (student does not yet successfully complete the activity, needs additional work)**

Product Quality

1. Quality of solder joints.	4	3	2	1
2. Proper soldering technique used at all times.	4	3	2	1
3. Components were placed correctly.	4	3	2	1
4. Consistent following of directions.	4	3	2	1
5. Problems solved as required (missing components or different from specified).	4	3	2	1
6. Troubleshooting ability demonstrated when necessary.	4	3	2	1
7. Correct setup for board and component testing.	4	3	2	1
8. Workability of completed assembly.	4	3	2	1
9. Quality of ideas for other applications of either this board (or of the technology).	4	3	2	1

Personal Quality

1. Overall concern for craftsmanship.	4	3	2	1
2. Quality of design change/adaptation ideas.	4	3	2	1
3. Teamwork ability.	4	3	2	1
4. Safety consciousness demonstrated when handling all electrical devices as well as when working with hot solder.	4	3	2	1
5. Workplace kept neat and orderly at all times.	4	3	2	1

Note: This assessment can be used as a peer, self or instructor tool.



Smart House Focus Questions

1. Define and discuss the term "Smart House." What kinds of devices are typically used? _____

2. What kinds of functions are typically controlled by smart house technology? _____

3. Based on current practice and the current direction of technology, identify and discuss 5 new devices or applications which might be realistically expected to be included in the "smart house" technology of the future. _____

4. Identify and discuss the barriers which are keeping existing smart house technology from being built into "existing" and "new" construction. What could be done to overcome each of these barriers? _____

5. Identify and match the cultural values which have created the need for smart house technology. One example is the value placed on convenience by people in our culture. _____

Smart House TechFolio

Create a Smart House TechFolio which could include the following items plus more as you wish to add:

- CAD printouts with a smart house layer included
- A bill of materials/equipment list for a smart house (or a smart room)
- A brainstormed list of possible functions to control in a smart house using existing technology (that available on the market today)
- A reflective report on how smart house technology development mirrors society's values and problems (convenience, security, etc.)
- Plans of procedure documenting the construction, assembly, or installation of devices
- A list of smart house equipment and supply vendors
- PC board designs
- Ergonomic Information (lighting, temperature, etc.)
- Other

Note: On page 82 of the Performance Based Education Implementation Handbook there is a sample of a method which could be used for scoring TechFolios.

By Mike Maxwell



Instructor Resource

Smart Houses

Content Outline

1. Introduction

- What is a smart house
- How does a smart house work

2. Infrared Detector

- Device that detects invisible infrared waves
- Explanations of circuit
- Application of circuit

3. Pressure Switch/Security Alarm

- What is pressure
- Explanation of circuit
- Application of circuit

4. Simulation Security Panel

- Security Panels
- Explanation of circuit
- Applications of circuit
- Additional activity

5. Door/Window Sensor Security

- Magnetic Switches
- Application of circuit

6. Smart House Wall Section

- Modules
- Application of modules

7. Smart House Computer Control

- Computer application
- Computer simulation of smart house

Instructional Resources

Books

Johnsey, R. Design and Technology Through Problem Solving. Simon and Schuster.

McComb, G. (1987) Electronic Life-Style. Master Publishing, Inc.

Forrest, M., III (1992) Engineer's Mini Notebook. Radio Shack.

Magazines

Gilmore, V. E. (1990, September) U.S., Japan, Europe: The World's Smartest Houses. Popular Science, pp. 56+.

Williams G., III (1989, September). Tomorrow in America. American Legion Magazine, pp. 21+.

Gilmore, V. E. (1988, August) Smart House. Popular Science, pp. 42+.

Normile, D. (1993, November) From the Land of Thinking Machines. Popular Science, pp. 56+.

DiChristina, M. (1992, May) Home Newsfront. Popular Science, pp. 48+.

Video

AIT Video Series. Exploring Technology Education. Units on construction have information on smart house technology. Available from MVRC.

Suppliers

Chaney Electronics; P.O. Box 4116; Scottsdale, AZ 85261

Heathkit; Benton Harbor, MI 49022



Glossary of Terms

Base House Code - the house code on which the rocker keys on the interface operate.

Boot - means to start the program, either by turning on the computer with or without the disk in the drive.

Capacitor - a device capable of storing electric energy. It is constructed of two conductor materials separated by an insulator.

Circuit - a system of conductors and devices through which electrons can move.

Download - the transfer from the computer to the interface. This occurs when you complete an operation by pressing the return key on the computer keyboard.

Double Pole Double Throw (DPDT) - a switch with two terminals that can be connected to one of two other pairs of terminals, depending on how it is thrown.

Electrolytic Capacitor - a capacitor made with an aluminum positive plate, electrolyte as a negative plate and a thin oxide layer on the aluminum as the dielectric.

Field Effect Transistor (FET) - a semiconductor device that conducts from one terminal called the "source" to another terminal called the "drain" when a voltage is applied to a third terminal called a "gate".

House Code - all X-10 modules and manual controllers are normally set so that their household dials are the same letter. The interface is normally set to household "A" but can be changed.

Infrared - lying outside the visible spectrum at its red end.

Insulator - a material that will not conduct current. An object made of an insulator material that supports or separates conductors in a circuit.

LED (Light Emitting Diode) - a PN junction diode that emits light when it is biased in the forward direction.

Ohm Resistor - is a device that will oppose the flow of current in an electrical current.

Piezo Disc - a disc with the ability from some types of crystals to produce a voltage when out under certain types of stress.

PNP Transistor - a transistor which has P type material for its emitter and controller and N type material for its base.

Receptacle - a contact device installed at an outlet so that a plug can be connected.

Resistor - a device that will oppose the flow of current in an electrical circuit.

Schematic - an electrical diagram that shows components as symbols and electrical connections of components to each other.

Science - the study of why natural things happen the way they do.

SCR (Silicon Controlled Rectifier) - a semiconductor device having an anode, cathode and gate used for current values that are usually higher than those carried by transistors.

SPDT (Single Pole Single Throw) - a switch used to open or close one circuit.

Tantalum Capacitors - capacitors that utilize paper soaked with electrolyte as insulator between tantalum plates, to hold down the heat.

Technology - the use of knowledge to turn resources into the goods and services that society needs.

Transformer - a device used to step up or step down voltage by induction. An electrical device used to transport energy from one circuit to another circuit of the same frequency.

Trimmer Resistor - a variable resistor that is used to make very small changes in the resistance of a circuit.

Unit Code - each X-10 module is set to a different unit code (between 1 and 16).

Upload - transfer of data from the interface to the computer. It occurs when the interface is reconnected to the computer and the program is loaded.

Safety Factors

- Follow all safety rules for working in a lab.
- Follow all safety rules concerning hand tools and power machines.
- Never work on appliances or outlets with appliance plug'n or power on to outlets.
- Never use water on an electric fire.
- Solder will melt at 270 degrees Fahrenheit or higher. At these temperatures, you can get a bad burn. Do not let any of the melted solder touch your skin.
- Avoid touching anything electrical with damp hands or water on floors.

Instructional Suggestions

Motivation

- Arrange for field trips to smart houses.
- Arrange for guest speakers.
- Arrange for ways to integrate smart homes and skill into the other class work.
- Arrange for ways to "show off" students work to the student and the public.

Prerequisite Information

- Knowledge of basic tools and safety.
- Basic computer knowledge.
- Electricity/Electronics wiring and soldering.

Demonstrations

- How to properly solder circuits.
- How to run computer software.
- How to wire circuits.
- How to properly operate power tools.

Academic Enrichment

- Have students do reports for public school publications.
- Have students interact with computer science teacher.
- Have the class build a full size model of one or two rooms and equipment with smart house devices.
- Design a home (scale model) and use smart home devices.



Related TAMS

- Introduction to Energy and Power Technology Guide
TAM 18 Using Electric Instrumentation
- Introduction to Communication Technology Guide
TAM 10 Intercom Systems
TAM 11 Home Security Monitoring Systems
- 1990 Implementation Workshop TAMS
TAM 2 Fiber Optics
- 1991 Implementation Workshop TAMS
TAM 4 Modern House Construction in the Middle School

Assessment/Evaluation Suggestions

- Develop a list of criteria which will be used in either instructor, peer, or self assessment for all products produced in the TAM.
- Develop a series of scenarios for students to problem solve. Evaluate their problem solving ability.

Note: Review the assessment items which are presented throughout the Performance Standards TAMS for ideas which can be adapted for this TAM. You should also refer to the Performance Standards Implementation Handbook for additional assessment examples and ideas.

Summary

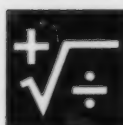
Just imagine of all the possibilities of a smart house. In this TAM you have just scratched the surface. With the advancement of technology there are new devices being developed everyday. There are many more devices covered here and the career opportunities, well are endless.



In Motion!

Goal

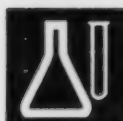
The goal of this TAM is to give the students a basic understanding of the technology behind video as an information medium, and some of the ways in which it is created to achieve its desired effect on an audience. Upon completion, students should be able to demonstrate an awareness of the basic techniques of video production.



Mathematics



Communications



Science



Social Studies



Fine Arts



Health



Technology

Performance Standards

- Comprehend the need for a mood/atmosphere in film and video and analyze the atmosphere created by each, including lighting, special effects, and music/sound track.
- Speculate the future of various areas of video and electronic communications, including telecommunications, video, and Superhighways.
- Analyze the various steps/sequences of a video production from conceptualization through the final product.
- Discuss the ethical implications of the present and future states of video and electronic communications, including media, social, cultural, and political topics.
- Comprehend how video technology operates as a social force affecting our everyday lives.
- Demonstrate the ability to read and comprehend the types of technical manuals included with high technology consumer items.
- Use video to communicate with superiors, peers, and society.
- Define those practices and terms used in video production, including basic shooting, editing and dubbing.
- Demonstrate the ability to work with highly specialized video equipment, including cameras, playback equipment, monitors, wiring, and electronic editors.
- Demonstrate all safety and proper operating procedures when interacting with video technologies and when using the tools/equipment associated with video technologies.
- Identify the various foundation skills for different career options in video productions.



Introduction

Video production has a tremendous influence on our attitudes and perceptions of the world around us. In fact, the media may be one of the most powerful tools in modern culture for shaping values and conveying information. We depend heavily on video technology for:

- Information - news and educational programming
- Entertainment - movies, cartoons, prime-time television
- Persuasion - advertisements
- Personal - home video

What are the techniques of videotaping, and how are they applied to achieve the end effect? Everything that goes into a video must be very carefully planned ahead of time in order to convey a message as effectively as possible. This includes lighting, camera angle, background music, and transitions between scenes. The activities included are designed to give the participants awareness of these aspects of video, through hands-on experiences. Activities include learning to use the equipment, editing with simple equipment, and shooting different types of videos, including a commercial, promotional video, and an action video. These activities are designed for a minimum of two students, or as many as six.

Objective Statement

The activities described in the following pages represent samples of activities which can be used to deliver the performance standards on page 1. Many additional activities can and should be used. Extreme care should be taken to connect each activity with appropriate activity objectives as well as with the performance standards. These objectives should be developed by the instructor and should be shared with and made clear to the students.

Activity 1

Getting To Know The Equipment



Integrated Activity Idea

Evaluate the manual for the camcorder. Are the features presented in a logical sequence? Are they easy to read? Do the illustrations match the equipment? How could the instruction manual be made more user friendly?

One of the first criteria for working with video production is learning to work with the equipment involved. In this activity, students will use the manual for the video camcorder to learn its functions.

Procedure

Note: This is an expensive piece of equipment. Handle it carefully and hold it securely. Do not force any switch.

Step 1 - Describe the Camcorder

- What format tape does it use (VHS, S-VHS, Beta, Hi 8, or 8 mm)?
- What brand of camcorder is it?

Step 2 - Power up the Camcorder

Using the manual:

- Read the section on connecting the battery
- Read the section on operating the camcorder on AC
- Read the section on charging batteries
 - How long does it take to charge them?
 - What is the voltage output?
 - How long can you shoot on a single charge?
- Set up the camera to operate on a battery
- Set up the camera to operate on AC

Step 3 - Loading the Tape

Read the section in the instruction manual on loading and ejecting tapes. When you understand how to do this,

1. Eject the tape if there is one in the camcorder;
2. Put in a tape, and close the door.



Focus: Depending on how far an object is from the camera, the lens needs to adjust focus, just as your eyes, a telescope, a microscope, or any other optical device must adjust or be adjusted.

Your camcorder probably has two options for focusing: auto focus and manual focus. The auto focus has a distance sensor that determines the distance from the camcorder to the subject, and a microchip that controls a motor to focus the lens. That way, if you are shooting an action scene, you can concentrate on the subject, and not worry about focus. In some cases you may need to override the auto focus: For example you can start shooting a subject out of focus so that it is a blur, and then focus in on it as a special effect. In this case, you would use the manual focus option.

In the next step, you will explore ways to use the focus controls of your camcorder.

Step 4 - Explore the Focus Controls of Your Camcorder

Read the section on focusing in the camcorder owners manual.

- ☐ 1. Be sure the power to the camcorder is turned on.
- ☐ 2. Make sure a blank videotape is loaded.
- ☐ 3. Set the camcorder to record, but do not press the button to start shooting.
- ☐ 4. Set the camcorder to auto focus, and point it to different places in the classroom. Notice that as you do so, the lens turns as the camera automatically focuses it.
- ☐ 5. While the camcorder is set to auto focus, look through the viewfinder, and watch through the viewfinder. Notice the effect on the focus as you look at different parts of the room through the viewfinder.
- ☐ 6. Set the focus to manual focus.
- ☐ 7. Look through the viewfinder at different parts of the classroom. Notice that only objects a certain distance from you are in focus. The rest are out of focus. What determines which objects are in sharp focus, and which are blurry?
- ☐ 8. Point the camcorder to an object that is out of focus, and focus the camera manually to bring it into focus.

Time & Date: Have you noticed that on some of the videos shown on America's Funniest Home Videos™ have the date and time shown at the bottom of the screen? Your camcorder has the ability to "stamp" the time and date onto the videotape. This is useful if the user wants to show when a particular video was shot, but you won't want it to show throughout the video sequence. It will be handy to know how to turn it on and off for your actual shooting.



Integrated Activity Idea

Draw a camcorder. Label the parts and describe the function of each.



Integrated Activity Idea

Write a simplified camcorder manual which corresponds with the model you are using. Use desktop publishing and graphics to make it look good and read clearly.

Step 5 - View the Time and Date.

- ☐ 1. Read the section in the owner's manual on how to display the time and date.
- ☐ 2. Make sure there is a tape in the camcorder, and that it is set to record (but don't press the record button).
- ☐ 3. Set the camcorder to display time and date.
- ☐ 4. Set the camcorder so that it displays only the picture (it may show battery charge, but that does not show up on the videotape).

Zooming: Most camcorders have a zoom lens. This allows you to see a large area (wide angle lens), or a small area like a telescope (telephoto lens). For example, if you wanted to show a shot of the general scene in a technology room, you would set the lens to wide angle. To zoom in on one particular student across the room, you would press the telephoto button. That way you can get a close-up shot without actually getting close to the subject.

Use the zoom lens.

- ☐ 1. Read the section in the owner's manual on how to zoom in and out.
- ☐ 2. Locate the manual zoom lever.
- ☐ 3. Locate the power zoom buttons.
- ☐ 4. Make sure there is a tape in the camcorder, and that it is set to record (but don't press the record button).
- ☐ 5. While looking through the viewfinder, use the manual zoom lever to zoom the lens out all the way out (wide angle shot). Note that the focus automatically changes to compensate.
- ☐ 6. While looking through the viewfinder, zoom the lens in all the way (close-up shot).
- ☐ 7. Try zoom in and out using the power zoom buttons.
- ☐ 8. Think about how you could use this effect. Discuss it with your lab partner.



Integrated Activity Idea

Examine historical films (often shown on educational programming) in the context of the equipment and techniques available at the time. War footage is particularly useful, because wars were so well documented. Compare, for example footage from WWI, WWII, Korea, Viet Nam, and the Persian Gulf. How did the available technology reflect the quality of the footage?



Extreme Close-up



Moderate Close-up



Close-up



Medium Shot



Wide Angle



Extreme Wide Angle

Figure 1 - Zooming

Special effects: Your video camcorder may not have all the special effects listed below. Depending on the model, you may have fade in and fade out buttons, single frame button, and titling buttons.

Fade: This is used to make transitions between scenes in a videotape. Fade in starts with a completely black screen and the image fades onto the viewer. Fade out starts with the image, and fades to a black screen. For example, when making a transition from one scene to another, an editor would hold the last frame of a scene, fade it to black then fade in the next scene.

- ☐ 1. Read the instruction manual to see whether the camcorder you are using has a fade feature.
- ☐ 2. Can you fade to black and/or fade to white? Think of ways you can use this feature.
- ☐ 3. Practice fading to and from white, or fading to and from black.

Single frame: allows you to use the camcorder to do animation. By shooting one frame, moving the characters slightly, then shooting another frame, you will be able to easily do "claymation."

Titling: allows you to put titles onto a video, using the camcorder. Usually, this is a little difficult, but most camcorders have a way to do this.

- ☐ 1. Read the owner's manual to find out how to set up titles.
- ☐ 2. Set up a title with your name on the camcorder.



Integrated Activity Idea

Develop a chart showing the effect of focal length of the lens on the field of vision: For example, what is the field of view ten feet from the camera at maximum telephoto, medium, and maximum wide angle?

Materials Needed

Camcorder
Manual for camcorder
Notebook



Activity 2

Analyzing Commercials

Before actually shooting a commercial, it would be useful to see how the professionals do it. Advertising executives are highly paid to determine how to reach the audience who will buy their client's products. They need to know what kinds of television the customers watch and what kind of advertisements would appeal to them. For example, an advertisement for jeans would probably appeal to a younger set of viewers. The music would be upbeat and the scenes would be full of action. An advertisement for expensive jewelry would be geared toward individuals with a great deal of money and would probably be more dignified in its approach. The advertiser uses a number of tools in conveying information to potential buyers of a product. For example, zooming in on a face to show a person's response to a situation, using high or low camera angles, making "cuts" from one subject to another, and the use of music.

In this activity, you will analyze a number of television commercials to decide what the intended audience is and how effective the advertisers are in reaching that audience. Your instructor has videotaped commercials from different types of television shows. In the space provided below, answer the questions and evaluate the effectiveness of the commercial. There is a lot of information that you will need to record for each commercial, so it is possible that you will need to pause the VCR from time to time while you are writing.

Product advertised: _____

Age of people in the commercial: _____

What age audience do you think was targeted? _____

Type of music used: _____

Length of commercial: _____

How many different camera angles were used? _____



Integrated Activity Idea

Video advertising is an extremely expensive form of communication. Advertisers work closely with psychologists to determine how to persuade the most people to use a product or service. Talk with your psychology teacher, or research the topic of the psychology of persuasion.

What special effects were used? _____

Was there any animation in the commercial? _____

How long was each individual shot in the commercial? _____

What kind of TV show do you think this commercial was used with? _____

Does the advertisement mention competing products? _____

When going from one shot to another, did the camera make a sudden change, or was there a transition (such as a fade)? _____

Did the advertisement make the product appealing to you? _____

Did the commercial make you feel like you need to have the product? _____

Were you surprised to find what was being advertised by the approach the advertiser took to present his product or service? _____

Was the advertiser trying to sell you on the product or tell you what the product could do for you? _____

How do you think the commercial could have been made more effective? _____

If you were making a commercial, did you get any ideas from watching this one? _____



Activity 3

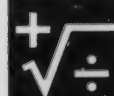
Commercial

Commercials involve much more than just shooting a video of someone telling the viewing audience how great a product is. The video must show the audience the product in its best light. It must make that product as desirable as possible.

Safety Considerations

While video production is generally a safe process, there are several things to watch for:

- When using any electrical equipment, such as lights, place the cords so that people are not likely to trip over them.
- Lights get HOT very quickly. Use caution when handling them.
- If using ladders, place them where people will not bump them.



Integrated Activity Idea

Develop a budget for producing and airing a thirty-second commercial. Include wages for production people, actors, equipment costs, cost of electricity, and cost of air time.

Procedure

This activity and set of procedures is designed to guide you in making a video commercial. It is important to remember that making a video is just like everything else that is made in technology education. The first step must always be to plan and design.

1. Select one commercial style you would like to use. It does not need to be for the same product, but just look at the overall way the product is presented.
2. Design your commercial. This is a good time for a brainstorming session with your production crew. When brainstorming, write down all ideas, no matter how silly. Here are a few things to discuss:
 - What are you going to make an ad for?
 - What is unique about it?
 - What could you say or do to make people want to buy it?
 - Who will be watching the ad?
 - Who would be buying the product?
 - Where could it be bought?
 - How long will the ad run?



Integrated Activity Idea

Make a video which is designed to teach and illustrate the basic elements of communication theory to students in an exciting and engaging manner.

3. Develop a storyboard. This is a series of rough sketches that give an idea of what the advertisement will look like. While some members of the crew work on the storyboard, the others should be working out a script so that the two go together. Here are a few suggestions:

- Keep it simple. It is easy to get carried away with fancy ideas.
- Keep in mind the kinds of material and space you have to work with. For example, you might have a great idea about shooting footage of a 4 x 4 pickup truck slinging mud, but will you be able to actually shoot the footage?
- Think about product endorsements by a celebrity (such as an athlete, scholar, teacher, principal, or someone from the community).
- Advertising time on television is extremely expensive. Most ads run for only thirty seconds. How can you get your message across in that length of time?
- Are you going to add music? If so, be thinking about what you want to use, as well as how you will sequence and match it to the video images.
- Remember: The pre-planning phase is where most of the creative work is done!

Show the storyboard and preliminary script to your instructor for approval.

Instructor's Initials



Technology Idea

Use a CAD system (or other drawing program) to develop 1) an organizational chart of all individuals involved in your video production, and 2) a timeline showing when each task of producing the commercial will be completed.

4. Develop the final script. Include the following:

- ☐ Description of the set
 - list of props needed*
 - location of props*
- ☐ Camera placement
- ☐ Light angles
- ☐ Location of the actors
- ☐ Script for the actors to read
- ☐ "Blocking" (directions for the actor's movement)
- ☐ Movement of the camera (zoom in, zoom out, etc.)
- ☐ Titles to be used.

5. Have your instructor OK the final script.

Instructor's Initials



Extreme closeup of Corny Flakes.
- crackling sound -



Zoom back to medium shot.
- fade into music -



Hand reaches out, gets spoon of cereal.
- continue music -



Spoon comes toward camera.



Person tells how good they are.



Tells viewer to buy Corny Flakes.

Figure 2 - Storyboard



Integrated Activity Idea

Shooting videos can require large amounts of electricity for lights and special effects. One of the jobs of the lighting director is to be sure that the lights do not overload the electrical system. Fuses to protect the electrical system are rated in AMPS. Amps = Watts/Volts. For example, a 100 watt light bulb would consume $100/110 = 0.91$ amps (assuming 110 volts). If you needed two 2000 watt spot lights and three 500 watt flood lights, how many amps would that draw? Would a 15 amp circuit breaker handle the load? If not, how could the lighting system be changed? Assuming that it took two hours to shoot the commercial, and that electricity is 12 cents per kilowatt-hour, how much will the electric bill for the five lights be?

6. Assign jobs. You should have the following:

- ☐ **Director**- makes sure everyone is in the right place, tells the cameras when to roll and when to stop (cut).
- ☐ **Cameramen**- one for each camera to make sure the cameras are in position and to move the cameras during shooting.
- ☐ **Actors**
- ☐ Optional: props directors and lighting directors

If you are going to use cue cards, make sure they are ready to go and in order. It is a good idea to number them to make sure they are in the right sequence.

7. Do a "dress rehearsal". That is, go through the entire commercial without the cameras rolling, to make sure everyone knows their parts, locations, and that the props work properly. Spend some time discussing with your actors and crew what could have been done to make the commercial go more smoothly. Write down your ideas, so you can use them when you start shooting.

8. Shooting the video: This is where all the pre-planning comes together. Make sure you have the following ready before shooting:

- ☐ All props
- ☐ Lights set up and ready to go
- ☐ Cameras on tripods in position
- ☐ Actors know their lines, if they are not reading from cue cards

When you are ready to shoot the commercial, make sure everyone is in place and all the props are ready. This is where the director says "roll camera", then "action". You will want to start recording before the action starts. Later, you will be able to edit out the parts you don't use. Go through the commercial the way you went through the dress rehearsal, using any changes you decided to make.

If you only are using one camera, you should shoot several takes of the same commercial, using different camera angles each time. That way, you can use the best shots from each take. Even if some mistakes are made in the commercial, go ahead and keep shooting and finish up the commercial. There may be parts that you can use. Later, when you edit the commercial, you will put it all together.

9. When you have at least three takes of the commercial, strike the set. That is, take down the lights and camera and put the props away. Make sure you eject the videotape from the camera, label it and write the date down so you can identify it later. For example, you might call it "Choco-bomb Cereal commercial 3/18/94". Your videotape is now ready for editing. Procedures for editing will be described in the next activity.



Materials Needed

Camcorder

Manual for camcorder

Notebook

Videotape of different television commercials. This should be a videotape that has been made by the instructor showing at least 10 different commercials. These should be commercials of the nature that students could make in a small studio (for example breakfast cereal, deodorant, toys, or light bulbs). If possible, show commercials made with different techniques, such as straight shots, animation, etc.

Activity 4

Basic Editing

Once the videotape has been shot, it goes through a process of editing. That is, decisions must be made about which video segments should be used and how they should be arranged. Since you have shot the video from several different angles, you have the opportunity to combine shots from each take to come up with the most effective way of conveying your message. While computerized editing systems are available, in this activity, you will be selecting segments and manually copying them from the camcorder to videotape.



Integrated Activity Idea

Develop models and backgrounds for use in videotape special effects.

Viewing the Raw Footage

If you have two TV/VCRs available, it will be helpful to view both takes at the same time. This will help you decide which shots you want to use by comparing them to each other. Otherwise, you can play the tape from the camcorder through the VCR and view the footage that way.

Step 1 - Prepare the Videotape for Viewing on VCR(s)

- If you have two TV/VCR units and the camcorder records VHS format, set up the two TV/VCR units side by side and put one tape in each unit.
- If you have two TV/VCR units, and the camcorder records a format different than VHS (such as 8 mm) follow the instructions below to copy the video onto VHS format video tape.
 1. Read the instruction manual for the camcorder that explains how to connect the camcorder to the VCR. Usually, there is a cable that came with the camcorder. One end plugs into a special socket in the camcorder. The other end has two cables: one white and one yellow.
 2. Connect the cables from the camcorder to one of the VCRs, as shown in the instruction manual.
 3. Put a blank tape in the VCR.
 4. Set the VCR to RECORD.
 5. Set the camcorder to PLAY. You should be able to see tape in the camcorder play on the TV connected to the VCR.
 6. Repeat the above steps to copy the second tape onto another VHS tape, to give you two tapes that you can watch side by side. You are now ready to start deciding what parts of which tapes you wish to use in your commercial.
- If you only have one TV/VCR, follow the steps above to copy the tape onto VHS, if the camcorder uses a format other than VHS. If the camcorder uses VHS format, just put the tape in the VCR, and you will be ready to go.



Technology Idea

Visit the local cable company. What equipment do they use? How do they decide what channels to put on the air?



Step 2 - Making Editing Decisions

Rewind the tape and set the counter to 0. You will use the counter numbers to designate parts of the tape.

- Which camera angles were best for different parts of the commercial?
- How long will the commercial last? If it is too long, how will you decide how to make it shorter? If it is too short, how could you lengthen it?

Step 3 - Review the Storyboard

Which takes come closest to your original idea? Remember, you do not need to follow the storyboard exactly. It is possible that you have come up with something you like even better than the original idea.

Step 4 - View the 2 Videotapes

You may need to go through them several times. Note the numbers on the counter as you do so. This is how you will identify which segments you will use in the final product. Fill out the form for this activity. Below is an example of what it might look like.

Scene 1:	Scene 2:
Description_____	Description_____
Time:_____ Tape A or B (circle one)	Time:_____ Tape A or B (circle one)

Figure 3 - Sample Form

Which camera angles were best for different parts of the commercial? How long will the commercial last? If it is too long, how will you decide how to make it shorter? If it is too short, how could you lengthen it?

Step 5

Make a final decision on which takes you will use. Remember your audience, and how you want them to perceive your product. For example, a younger audience will probably expect a lot of changes in camera angle, and changes between close-up shots and wide angle shots. An older audience would probably require a more dignified commercial. Remember, this is a group project. Everyone should have a chance to provide input in making the decisions, but should be able to justify their viewpoints.

When deciding, try to match the audio (spoken) part of the video. A visual change (for example, camera angles or zoom) is an example, but the sound track should be smooth. For example, changing cameras in the middle of a sentence will break up the sound portion of the commercial momentarily. Look for logical



Technology Idea

Go to a TV station to see how video is developed, edited, sequenced and used.



Technology Idea

Make a science fiction videotape in which you use equipment in the classroom (robots, model rockets, computers, etc.) shot from unusual angles for effect.

breaks for changing camera angles.

NOTE: If you have two VCRs, it will be helpful to watch both takes at the same time so you can make a direct comparison.

Step 6

Once you have decided what shots you want to use, it is time to put it all together.

- If you have two TV/VCRs, connect them so that you can play one and record with the other. Figure 4 shows the normal way of doing this (it may vary from one model to another).

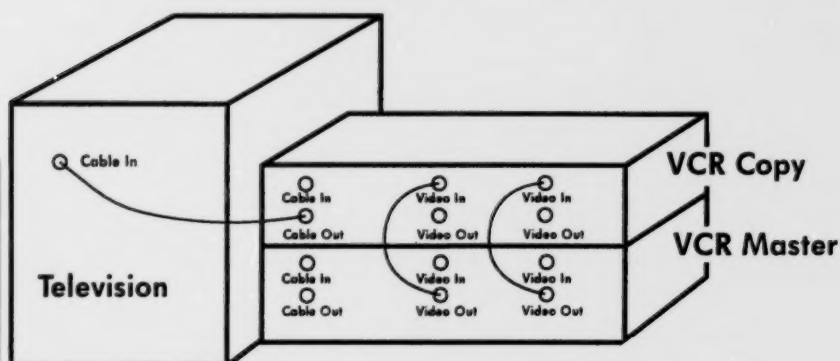


Figure 4 - Connections Between 2 VCRs



Technology Idea

Visit a local television studio. Some points to look for are: what are the jobs people do there? How did the people working there prepare for their jobs? What does the set look like? What are some of the production techniques?

- If you have only one TV/VCR, you will need to set the system up so that you can play the tapes with the video camera and record onto the VCR.
 - a. Put a blank tape into the VCR that you will be recording to.
 - b. Put the tape that has the first shot you wish to use into the VCR (or camcorder) that you will be recording from.
 - c. Press the RECORD button on the VCR your will record to.
 - d. Press PLAY on the unit you are recording from.
 - e. When you get to the end of the part of your commercial that is on the first tape
 - ◆ PAUSE the tape that you are recording onto.
 - ◆ Remove the tape that you were recording from.
 - ◆ Insert and PLAY the second tape.
 - ◆ When the second tape gets to the part you want to use, press PAUSE on the tape that you are recording to, to start it recording again. (It may take you a couple of tries to get it to work right, but remember, you can always start over, if you need to.)
 - f. Continue working back and forth between the two tapes, until you have the full one-minute commercial recorded.

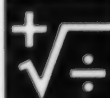


Step 7

You may wish to make a copy of the tape for each member of the team to take home.

Materials Needed

Camcorder
VCR (two preferred)
Videotape of the commercial shot in the previous activity.



Integrated Activity Idea

Video production uses a sequence of frames (individual still shots shown in rapid sequence). The speed at which a video is played is measured in frames per second. Normal television plays 30 frames per second. If it takes half a minute to set up each frame of an animation, how long would it take to film a thirty minute animation? If the animation required a crew of four people, each making \$15 per hour, how much would it cost?

Activity 5



Integrated Activity Idea

Use video to analyze the physical movements of an athlete, for example, a baseball swing.

Animation

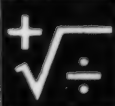
Animation is the process of "bringing to life" objects that normally do not move by themselves. Saturday morning cartoons are one example of animation. In this case, each frame is individually drawn and photographed. A second type of animation is computer-generated. This is used for simulations and often seen in commercials. The third type of animation involves filming actual objects one frame at a time, moving them slightly, then filming another frame and so on. An example of this is "claymation," so called because objects are made from clay and can be easily moved. The Coca Cola bear and California Raisin commercials are examples of this process. In this activity, you will be using claymation to create a video.

1. Discuss animation you have seen on television and movies. If possible, view a Gumby animation.
2. Plan out your animation. Discuss as many ideas as you can with the others you are working with. What props do you have available? What sort of story line can you come up with using the props? What can you add to the set? Do you need some sort of background? How long will the animation be?
3. Develop a storyboard. This is a dozen or so sketches of the main scenes of the animation. Try to keep things as simple as possible. At this point, you just want a general idea of what the animated videotape to be about. Remember: The pre-planning phase is where most of the creative work is done!
4. Develop a preliminary script, with a list of props. This should be as complete as possible, but you can still be open to new ideas as you go along.

Show the story board and preliminary script to your instructor for approval.

Instructor's Initials

5. Develop the final script. Include the following:
 - ☐ Description of the set
 list of props needed
 location of props
 - ☐ Camera placement
 - ☐ Light angles
 - ☐ Location of the characters to animate
 - ☐ Script: This needs to include directions for the movement of the characters. Since you will be adding the sound (dialog, music, sound effects) AFTER the animation, be sure to include these so that the animation will match the sound.



Integrated Activity Idea

Develop a video in which shapes transform from one to another.

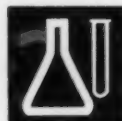


- ☐ Movement of the camera (zoom in, zoom out, etc.)
 - ☐ Titles to be used.
6. Have your instructor OK the final script.
- Instructor's Initials**
7. Assign jobs. You should have the following:
- ☐ **Animator** - moves the characters between frames.
 - ☐ **Camerasman** - is responsible for operating the camera: moving it, and shooting individual frames.
 - ☐ **Lighting Director** - makes sure lights are in the right places, and watches for glare, shadows, and any other problems associated with lighting.
8. **Shooting the video:** Animation requires special techniques. You need to set everything in place, put the camera on a tripod, and set the lights in place. If your camera has single frame capability, shoot one frame. Normal video shoots 30 frames per second. At this rate, how many frames do you need to shoot for a one-minute animation? If it takes you fifteen seconds to set up a frame and shoot it, how long would it take to do the entire shooting for a one-minute video animation? Instead of shooting at this rate, which would give a smooth animation (but take too long to shoot), you will shoot five frames per second. This will give a somewhat jerky animation, but will not take as long to set up and shoot. In fact, this will give the appearance of an old time movie. To do this, shoot six frames between each time you move the pieces. You already shot one frame, so shoot five more. Move the pieces a little bit. then shoot another six frames. At the rate of five frames per second how many times will you need to move your pieces?



Figure 5 - Animation Set

If your camera does not have a single-frame feature, you can still achieve the effect by putting the camera on RECORD, and using the PAUSE button every time you need to move the pieces. This will take practice, and you will find that some shots may be longer or shorter, but the effect can still be quite interesting.



**Integrated
Activity Idea**

Develop a video that shows the growth cycle of an insect, animal, or plant.

Either way, try a variety of camera angles. The most effective way to do this is to put the camera on a tripod and have the lights fixed in place. When you change the camera angle, it will appear as a sudden change, unless you move the camera a little bit between shots. The same is true of zooming in or out. If you want a slow zoom in for a close up, for example, you need to zoom in a little, shoot the six frames, then zoom in a little more, and so on.

9. **Editing** will be different in this type of animation. Because of the amount of time required to set up and shoot each shot, there will not be time for you to shoot through the entire sequence twice. This is why pre-planning is especially important.

Adding sound to the animation can be the most fun and creative part. This can take the form of dialog or music, or both. View the videotape. If you have recorded on to VHS format, you can simply put the tape in the VCR. Otherwise, you will need to connect the camcorder to the VCR, as shown in the operating instructions for the camcorder. **PLAY** the tape. You may wish to watch it several times while practicing the dialog and sound effects. Once you have it rehearsed so that it works, record the sound track onto a cassette tape, while watching the video portion. Try to keep it as well synchronized as possible. Some possible sound effects: dropping metal plates on the floor, dropping a book, squeezing the neck of a balloon as it deflates, striking notes on different musical instruments, shooting a cap gun, bursting a balloon, breaking a pencil, tapping on wood blocks (to simulate horses), or even tearing a piece of paper can make interesting additions to the animation video.

It may take several tries to get it right, but the hard part has already been done. Keep playing the video and taping the sound portion on cassette tape until you have it the way you want it.

10. Once the sound has been recorded, play back both the video and the audio clear through to make sure everything matches. To combine the video and audio together, connect the camcorder to the VCR video only. Do not connect the audio of the camcorder. For the audio portion, attach the RCA adapter to the EXT SPEAKER port of the cassette tape recorder, and the other end of the cable to the AUDIO IN of the VCR. This way, the VCR will record the video portion from the camcorder, and the audio portion from the cassette tape recorder. When everything is set up, set the VCR to **RECORD**, set the camcorder to **PLAY**, and set the cassette tape recorder to **PLAY**.
11. Finally, **PLAY** back the finished tape! This is the animation. If you wish to make additional copies, there are two ways to do this, depending on the type of equipment you have. If you are using a camcorder that uses VHS format, put the final video (called the **MASTER**) into the camcorder. Put a blank tape into the VCR. Connect the cable from the camcorder to the VCR, as recommended in the operator's manual (this time, connect



both the audio and video) ends. Set the VCR to RECORD and the camcorder to PLAY. If you have two VCRs available, you can connect them together with a coaxial cable. Put the master tape in one and a blank tape in the other. Set the VCR with the blank tape to RECORD and the VCR with the master tape to PLAY.

Materials Needed

Camcorder

Tripod

Videotape

Cassette tape recorder

Cable from earphones of tape recorder to audio in of VCR

Plasticine clay (an oil base clay that does not dry out)

Movable figures (such as Gumby figures, etc.)

Props (these could be model scenery, Legos, model cars, moveable action figures, etc.).

Optional: A Gumby videotape. These are available at many discount stores (such as Walmart) or video rental stores.



Integrated Activity Idea

Video is a powerful media for persuasion. Unfortunately, it is not always used to tell the truth. In many cases, advertisers and newscasters edit videotapes to show only what they want you to see, and to distort the truth.

- ◆ Discuss the effects of editing video to distort the truth on society. Can you come up with any examples?
- ◆ How could someone use the video techniques you learned in this module to slant the viewers opinion?
- ◆ What editing effects do advertisers use to make their products look better than they really are? Is this fair?



Technology Idea

Conduct an interview with a video editing professional. What does this individual's job include? Where did he or she learn how to do the work? What are the career options and possibilities? What kind of education and background should be obtained to pursue a future career in the field?

Activity 6

Computer Editing System

Compatibility Notes

This TAM requires the use of a camcorder with LINC remote capability. If you are not certain whether your model has this, contact Gold Disk Technical Support at:

Gold Disk Technical Support

P.O. Box 789, Streetsville

Mississauga, Ontario

L4M 2C2

(416) 602-5292 (voice)

(416) 602-0393 (fax)

The video editing described in Activity 4 provides you with a means of putting scenes together from two tapes, or "cleaning up" a tape for broadcasting. But it is time consuming. And what about special effects, such as fades? In order to do this, you need special video editing equipment.

Professionals usually use a computer to help them edit videotapes. This activity describes the use of the VideoDirector video editing system. Because the manual is well-illustrated and easy to read, the student is referred to the manual for most of the steps.

Procedure

1. Connect the computer, camcorder (or second VCR), VCR, and television, as shown in the instruction manual.
2. Make sure the transmitter end of the infrared cable is pointed at the infrared receiver on the VCR.
3. Connect the audio out and video out of the camcorder to the audio in and video in of the VCR (the audio is usually the cable with the white connector, and video is usually the cable with the yellow connector).
4. Test your connections. Read and follow the directions in that section of the manual.

NOTE: There are three ways to locate information in a manual.

- Thumb through the manual until you find it (not recommended)
- Look in the table of contents
- Look in the index at the back of the book

5. Start up the computer, and follow the instructions provided by your teacher to boot up the software. Note: Leave space for instructor to write boot-up instructions.



6. Test the configuration of your system. If everything checks out, you are ready to begin editing your tapes!
7. Review the storyboard (again, if you are using one) to refresh your memory of what the tape is for.
8. Read the section in the manual on building and editing an event list. It explains what an event list is and how to use it. Become familiar with the following terms:
 - Event marker
 - Clips
 - Scenes
9. Read the section on managing events. Be sure you understand how to:
 - move events
 - copy events
 - save an event list
10. Read the section "When to use calibration events". When you edit your tape, you will need to know how to do this to make sure the tape is in the right place.

CONGRATULATIONS! The hard part is over, and you are ready to start editing your videotape!!!

11. Make a tape assembly printout so that you have a hard copy to refer to. This will show what events you are using.
12. View the events one by one, so that you know what they look like.
13. Using the CUT, COPY, and PASTE commands, construct a sequence of events that follows your storyboard.
14. View your sequence of events. This is covered in the section titled "A Home Matinee".
15. Output your tape to VHS. This is covered in the section on assembling your output tape.
16. Show your finished video to your instructor. Be able to answer the following questions:
 - What are some of the advantages of using the computer to edit videotapes?
 - How did you build and edit your event list? What commands did you use?
 - How could you edit your events to tell a different type of story?



Technology Idea

Create a videotape in which you combine taped action scenes from television (such as *Star Trek*) with shots on a set of your own to create a new episode starring students in the class. This will require some careful editing!

Materials Needed

One or more videotapes to edit	IBM/compatible computer
VideoDirector editing system	TV/VCR with infrared remote
Operating manual for VideoDirector editing system	
Camcorder with LINC remote input or second VCR and adaptor	
Raw videotape - indexed (event list has been created and stored in the computer)	

Activity 7

Promotional Videotape



Integrated Activity Idea

Examine the techniques used by government officials as they use the video medium to promote themselves (news conferences, debates, commercials).



Integrated Activity Idea

Develop a video to promote technology education. It could be to:

- ◆ promote technology education courses to other students
- ◆ recruit students into teaching technology education
- ◆ convince administrators and parents of the value of technology education.

A promotional videotape is one designed to provide a positive message about something— to promote it. In this activity, you will create a videotape promoting your technology lab. Look around. This videotape could be used to make others aware of the technology lab, and what it involves. This could involve several techniques, including:

- Action shots of the lab
 - Interviews with students
 - Interviews with the instructor
 - Personal commentary about what you think of the lab
 - Special effects
1. Decide what kind of message you would like to broadcast about the lab. Brainstorm ideas with others working on the project:
 - What do you like best about Technology Education?
 - What equipment would be impressive to show in action?
 - What do you learn in class?
 - What is unique about your technology lab?
 - Who will be viewing the videotape and why?
 - ◆ Students who are thinking about taking Tech Ed
 - ◆ Your parents
 - ◆ Other teachers, counselors, and administrators
 - ◆ Judges in a videotape competition
 2. Develop a storyboard. This is a series of rough sketches that give an idea of what the promotional video will look like. When planning out your video, keep these suggestions in mind:
 - Is it something you can really do? It is easy to get carried away with fancy ideas, but you may not have time or materials to do it all.
 - Keep in mind the kinds of material and space you have to work with. You will probably do most of your shooting in the technology lab. If you are planning to do any shooting outside the lab, will you need your instructor's permission?
 - Think about getting comments by students who have already been through the program.
 - Who else could you talk to about the program?
 - What else could you use? For example, you might want to make a point about the technological world in which we live by editing in clips from television shows.



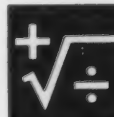
- A typical video would last about five minutes. Can you get the message across in that amount of time?
 - Be creative in your planning of the videotape.
 - Show the story board and preliminary script to your instructor for approval.
3. Develop the final script. Include the following:
- Props needed
 - People you will interview
 - Areas of the lab you will videotape
 - Light angles
 - Special effects, such as fades in and out.
 - Script to be read
 - Description of any footage from other video (such as video recorded from television).
 - "Blocking" (directions for the actor's movement)
 - Movement of the camera (zoom in, zoom out, etc.)
 - Titles to be used.
4. Have your instructor OK the final script.
5. Shooting the video: This is where all the pre-planning comes together. Make sure you have the following ready before shooting:
- All props
 - Lights set up and ready to go
 - Cameras on tripods in position
 - Everyone knows their lines, if they are not being interviewed.

Tips for Interviews

Talk with your subjects ahead of time. Let them know what you are doing and why. Try to make them feel comfortable with the idea of being interviewed and taped. Let them know ahead of time what questions you will ask them, so that they will know what to expect.

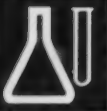
Zoom in tight on the person talking during an interview.

If there is a dialog between two people, such as one person asking questions, you may want to shoot the person asking the question; put the camera on PAUSE while you focus it on the second person, and then RECORD the response. This will give the effect of switching between two different cameras.



Integrated Activity Idea

Develop and shoot a videotape showing doubling times, and its effects. One example is the Persian Chessboard, in which students place one grain of rice on the first square of a chessboard, 2 grains on the second square, 4 on the third, 8 on the fourth, and so forth. Students could animate the process by shooting one second each time rice is put on additional square.



Integrated Activity Idea

Develop a videotape demonstrating a physical phenomenon: for example, electricity, Bernoulli's law, or motion of a falling body. How could stop action, slow motion and strobe lights be used?



Integrated Activity Idea

What is the hottest issue in the school? Who should you talk with about it? Interview that person or persons, and put together a news interview. Be sure to include the Who, What, When, Where, Why, and How!

Think about possible transitions. For example, rather than making a straight cut from a robot to a model rocket, you might want to fade the robot to white, then fade into the model rocket. The advantage to this is that it gives you a transition to and from any shot but you can always edit the fade out, if you decide not to use it. Because of this, you may want to fade into and out of each scene. When fading, hold the camera as still as possible (or have it on a tripod). Do not have any action taking place while you are fading into or out of a scene.

Use a variety of camera angles. For example, you might start with a close-up of a student using a computer, with the camera far away, but on maximum telephoto. Then you can go to wide angle, and show a large portion of the lab, and zoom in on another student in another area. This helps the viewer get an overall idea of what the lab looks like.

Be sure to shoot more footage than you think you will be able to use. It will probably take three minutes of raw footage for every minute of video that you can actually use. Remember, it is always easier to edit parts out than it is to go back and shoot more footage once you have started the editing process.

Interviews might suggest new ideas to you. Be open for changes. For example, a student might mention that a hydraulics activity helped in understanding pressure and force in Physics class. You might want to talk to the physics teacher and shoot students working with experiments that use principles similar to those applied in the Technology Education class.

6. When you have all the footage needed, it is time to assemble the tape into the final product. Editing requires several steps. Before you begin, take a look at the storyboard to refresh your memory. It is easy to lose sight of the original idea. If you make changes to the storyboard, it should be because it makes your promotional videotape better than the original.
7. The basic editing technique is covered in another TAM. Below are some of the main points:
 - If you did not use VHS format, copy your raw footage onto VHS by 1) connecting the camcorder to the VCR, and 2) setting the VCR to RECORD and the camcorder to PLAY.
 - Insert the VHS cassette into a VCR, and rewind it all the way.
 - Set the counter of the VCR to 0
 - View the videotape, taking notes on which segments to use. The segment information should include the starting number, ending number, time (including any fades, zooms, etc.), and a brief description of the scene.



- When editing an interview, be careful not to edit out any parts that would change the original message. In the real world, not only is this illegal, but it can also result in lawsuits.
- Add up the times. If it is over five minutes, you will need to look for ways to shorten it. If it is under five minutes, you will need to include some additional material. By using a sheet for reference, you should be able to tell which shots to include or cut.
- Remember, this is a group effort. Everyone involved should have some input.
- Once you have on paper all scenes to be used, you are ready to edit the tape.
- If you have two VCRs, put the master tape in one, and a blank tape in the other. Connect them as shown in the instruction manual.
- If you have one VCR, connect the camcorder to it, and use the PLAY function on the camcorder.
- When stopping the tape you are editing to, use the PAUSE button when you stop it. That way it will not have such noticeable breaks between shots.
- If you make additional copies of the finished product, you should remove the copy protect tab from the master tape first. That will keep you from accidentally taping to the wrong tape and ruining the master.

Materials Needed

Camcorder
Manual for camcorder
Notebook
TV/VCR

Activity 8

Action Videotape



Integrated Activity Idea

Develop an appreciation for the value of spoken language by designing and shooting a videotape without the use of sound. All communication would have to be through expression and pantomime.

Hollywood movies rely heavily on illusions to make the impossible seem real. With skillful editing, they cut from scenes of people to anything from space ships to covered wagons. Even though you don't actually see anyone on a space ship, you just know they're in there! Establishing this effect takes some simple scenery for the people shots, and elaborate models and special effects. Even when you see people, stunt doubles usually do the dangerous parts. Fortunately, the hard part has already been done! In this activity, you will use videotape footage from television to come up with a plot and script that takes advantage of the special effects, and edits people shots with the video from television. This will give you tremendous possibilities to use your imagination! It can be as simple or as elaborate as you have time for. For this TAM, Star Trek will be used as an example. Feel free to use any other videotape that has special effects that interest you.

Safety Considerations

While video production is generally a safe process, there are several things to watch for.

- When using any electrical equipment, such as lights, place the cords so that people are not likely to trip over them.
- Lights get HOT very quickly. Use caution when handling them.
- If using ladders, place them where people will not bump them.



Technology Idea

Shoot a training video, or shots of a sports team in action for later analysis that could improve the performance of the team. You could also develop a training video on how to assemble, manufacture, build, or construct a product.

Procedure

1. View the videotape provided:

- Rewind it and set the tape counter to 0.
- As you view the tape, note time of sequences, and counter numbers that you think you can use.
- What would be impressive to show in action?
- How can you write a script around it?
- Can you come up with costumes that match the actors in the videotape? If so, you can use clips from the videotape that don't show the actors close-up. This will also allow you to use stunts that you couldn't possibly do in the technology lab!



2. Develop a storyboard. This is a series of rough sketches that give an idea of what the video will look like. When planning out your video, keep these suggestions in mind:

- Is it feasible? You probably have limited time and materials to work with. It is better to keep it simple and be able to get through the entire video than to do something that you can't finish!
- Keep in mind the kinds of material and space you have to work with. You will probably do most of your shooting in the technology lab. If you are planning to do any shooting outside the lab, will you need your instructor's permission?
- Are you going to need any "extras" for group scenes? If so, how will you get them to work with you?
- What sort of scenery will you need? For example, can you arrange computers and furniture to make a convincing control room for a Galaxy Class starship?
- Develop a theme for your video. Can you make it convey a message, as well as be entertaining?
- Develop a conflict: for example, a battle between good and evil. This is a classic trait of the original Star Trek series.
- Come up with an appropriate resolution to the conflict.
- See if you can end the video on a humorous note.
- Be creative in your planning of the videotape.

This is a pretty tall order. It may take you three or four class periods before you have a story worked out, and storyboards made.

Show the story board and preliminary script to your instructor for approval.

3. Develop the final script. Include the following:

- Props needed
- Lines for the actors
- Segments of video from television (with description, counter numbers, and times)
- Light angles
- Special effects, such as fades in and out.
- "Blocking" (directions for the actor's movement)
- Movement of the camera (zoom in, zoom out, etc.)
- Titles to be used.

4. Have your instructor OK the final script.

Instructor's Initials



Technology Idea

Make an action video of a procedure or process used in technology education:

- ◆ How to operate a camcorder
- ◆ How to operate a plastics vacuum molder
- ◆ How to make and use a photoemulsion screen printing system
- ◆ Other



Technology Idea

Develop a videotape that shows students how to do an experiment from start to finish.

5. Shooting the video: This will be the tricky part, because you will be taping all the scenes by location. For example, if some of the scenes are in the control room, shoot them all in one session, then edit them into their places in the videotape later. Then shoot all the scenes that take place on the next location (such as the planet's surface) in one session. This will save time, because you will only need to set up the scenery for each location one time. This will take careful pre-planning. Make sure you have the following ready before shooting:

- All props
- Lights set up and ready to go
- Cameras on tripods in position
- Everyone knows their lines (or cue cards ready).

Tips for Shooting

- Rehearse all parts ahead of time.
- Don't plan on everything going right the first time!
- If you have time, you will want to make several takes of each scene that you shoot, using different camera angles.
- Remember to close in tight on faces.
- You may want to PAUSE the video camera when you change views from one person to another while they are talking. This will save editing time later.
- Do you have props you can use, such as a model rocket?
- Think about possible transitions, such as fading in or out. Most camcorders have this capability.
- Use a variety of camera angles. For example, you might start with a close-up of the captain, with the camera far away, but on maximum telephoto. Then you can go to wide angle, and show a large portion of the control room, and zoom in on another officer on the deck.

The basic editing technique is covered in another TAM. Below are some of the main points:

- If you did not use VHS format, copy your raw footage onto VHS by 1) connecting the camcorder to the VCR, and 2) setting the VCR to RECORD and the camcorder to PLAY.
- Insert the VHS cassette into a VCR, and rewind it all the way.
- Set the counter of the VCR to 0
- View the videotape, taking notes on which segments to use. The segment information should include the starting number, ending number, time (including any fades, zooms, etc.), and a brief description of the scene.
- Add up the times. Try to keep the entire video around 15 minutes.
- Remember, this is a group effort. Everyone involved should have input.



Technology Idea

Contact the local cable company to see if they would be willing to air a fifteen-minute video each week made by your class.



- If you have two VCRs, put the master tape in one, and a blank tape in the other. Connect them as shown in the instruction manual.
- If you have one VCR, connect the camcorder to it, and use the PLAY function on the camcorder.
- Because parts of your video are on two different tapes (the part from television with the special effects, and the part you shot), you will need to be careful in switching tapes back and forth. This will make it important to keep track exactly where you are on each tape.
- When stopping the tape you are editing to, use the PAUSE button when you stop it. That way it will not have such noticeable breaks between shots.
- If you make additional copies of the finished product, you should remove the copy protect tab first. That will keep you from accidentally taping to the wrong tape and ruining the master.

Materials Needed

Camcorder
Manual for camcorder
TV/ VCR
Action videotape (such as from a Star Trek episode)
Notebook

Assessment

Scoring Rubric for Activity 5 - Animation

Performance Standard	Wgt. %	Exemplary 2 pts.	Acceptable 1 pt.	Not Yet Acceptable 0 pts.	Sub total
I. Creative Thinker					
Comprehend the need for a mood/atmosphere in film and video and analyze the atmosphere created by each, including lighting, special effects, and music/soundtrack.	x1	Student defines/describes mood of animation project per teacher/text criteria with 100% accuracy.	Student defines/describes mood of animation project per teacher/text criteria with at least 70% accuracy.	Student defines/describes mood of animation project per teacher/text criteria with less than 70% accuracy.	2 x 1 = 2
Speculate the future of various areas of video and electronic communications, including telecommunications, video, and superhighways.	x.5	Student submits a 1 page technical memo/presentation describing a teacher assigned future communication area.	Student submits either 1 page memo or oral presentation of teacher assigned future communications area.	Student does not complete the technical memo or oral presentation of teacher-assigned communication area.	2 x .5 = 1
II. Critical Thinker					
Analyze the various steps/sequences of a video production, from conceptualization through the final product.	x1	Student correctly analyzes all steps of the animation project per the teacher/text criteria.	Student correctly analyzes all steps of the animation project with at least 70% accuracy.	Student analyzes all steps of the animation project with less than 70% accuracy.	2 x 1 = 2
III. Contributing Citizen					
Discuss the ethical implications of the present and future states of video and electronic communications, including media, social, cultural, and political topics.	x2	Student correctly discusses all ethical implications (per teacher/text criteria) that may be derived from this animation project.	Student discusses all ethical implications of this animation project with at least 70% accuracy.	Student discusses ethical implications of this animation project with less than 70% accuracy.	2 x 2 = 4
IV. Self-Directed Learner					
Comprehend how video technology operates as a social force affecting our everyday lives.	x.5	Student correctly discusses (per preset criteria) how animation has influenced lives.	Student discusses with 70% accuracy how animation has influenced our everyday lives.	Student discusses (less than 70% accuracy) how animation has influenced our lives.	2 x .5 = 1
V. Problem Solver					
Demonstrate the ability to read and comprehend the types of technical manuals included with high technology consumer items.	x.5	Student operates video camera and VCR for animation project per manufacturer's recommendations.	Student operates equipment for animation project with less than 3 errors as outlined by manufacturer/teacher.	Student operates equipment for animation project with more than 3 errors as outlined by manual/teacher.	2 x .5 = 1
VI. Effective Communicator					
Use video to communicate with superiors, peers, and society.	x.5	Animation message is consistent with objectives of storyboard.	Animation storyboard is consistent (less than 2 errors).	Animation and storyboard are not consistent (more than 2 errors).	2 x .5 = 1
Define those practices and terms used in video production, including basic shooting, editing, and dubbing.	x.5	Student correctly defines practices/terms (per teacher/text) with 100% accuracy.	Student correctly defines practices/terms with at least 70% accuracy.	Student defines practices/terms with less than 70% accuracy.	2 x .5 = 1
VII. Quality Producer					
Demonstrate the ability to work with highly specialized video equipment, including cameras, playback equipment, monitors, wiring and electronic editors.	x2	Student successfully completes animation project by correctly working with all associated equipment.	Student successfully completes animation project but requires limited teacher assistance with equipment (fewer than 3 situations).	Student completes animation project but requires constant teacher assistance (more than 3 assistance situations).	2 x 2 = 4
Demonstrate all safety and proper operating procedures when interacting with video technologies and when using the tools/equipment associated with video technologies.	x1	Student correctly completes animation project using all proper operating procedures and all proper safety procedures.	Student completes animation project by practicing all safety procedures while experiencing minor operating procedure differences.	Student experiences either major operating procedure problems, minor/major safety problems, or both.	2 x 1 = 2
VIII. Technical Foundations					
Identify the various foundation skills for different career options in video productions.	x.5	Student correctly identifies foundation skills for animation career per teacher/text.	Student identifies foundation skills for animation career with 70% accuracy.	Student identifies foundation skills for animation career with less than 70% accuracy.	2 x .5 = 1

Total: 20 out of 20 Possible



Short Answer Essay Questions

Activity 1: Getting to know the equipment

1. Sketch the video camera, showing the location of the various controls.
2. How long can you use the camcorder on one set of batteries? _____

3. Why might you want to use the manual focus instead of the automatic focus? _____

4. How could you make the camera seem to move away from the subject without moving it? _____

Activity 2: Commercials

1. How do advertisers decide which TV shows to put their commercials in?

2. What are some techniques advertisers use in keeping the viewers' interest? _____

3. What are some of the emotions the advertiser tries to bring out to sell a product (such as fear, pride, humor, etc.)?

4. Why do television shows have commercials in them in the first place?

5. Why do advertisers put commercials on television? _____

6. How would television be different without commercials (besides the obvious, how would television stations pay for their operations)? _____

Activity 3: Making a Commercial

1. How did you decide what product to advertise? _____

2. If you could choose any television show to advertise your product on, which show would it be? Why? _____



Activity 4 Checklist

Yes	No
☐	☐
☐	☐
☐	☐
☐	☐

- storyboard complete
- editing equipment properly connected
- instructions for editing read ahead of time
- master and copy tape ready

Activity 5: Animation

1. What is animation? _____

2. What are three different ways of making animation? _____

3. What are some of the same things you do for an animation that you would do for a non-animated videotape? _____

4. How is animation used in commercials? What is the advantage of animation over using actual characters playing parts? _____

5. Describe the process of shooting a claymation video. _____

Activity 6: Computer Editing

1. How does using a computer make the job of editing simpler? _____

2. What special equipment is required for editing in this activity? _____

3. What are events and how are they used in editing? _____

4. If you needed to use the manual to see how to use the event marker, how could you find this information quickly? _____

5. How could editing out parts of a video be used to slant the viewer's opinion? _____

TechFolio

Develop a video techfolio which includes the following items:

- Documentation about your camcorder (features, operating procedures, etc.)
- Sample storyboards for specific purposes
- Commercial analysis sheet
- Scripts for video (action, commercial, etc.)
- Lighting requirement tables
- List of equipment and vendors
- Documentation of the video editing process
- A finished promotional video for your Technology Education program
- A short report on the basics of editing, lighting, framing, etc., when making videos
- An edited video of peers on a current issue affecting teenagers.
- Other



Product Assessment for Activity 7 - Promotional Videotape

- 4 - Excellent (student successfully completes activity & displays mastery of subject/content)**
- 3 - Good (student completes activity with good quality)**
- 2 - Needs Improvement (student completes activity without demonstrating mastery of subject matter or activity performance requirements)**
- 1 - Not Acceptable (student does not yet successfully complete the activity, needs additional work)**

1. Idea quality.	4	3	2	1
2. Idea originality.	4	3	2	1
3. Story Board quality (completeness and writing quality). ...	4	3	2	1
4. Overall appropriateness of image framing throughout various shots.	4	3	2	1
5. Lighting quality & appropriateness.	4	3	2	1
6. Appropriate camera angles used throughout.	4	3	2	1
7. Quality of editing (transitions, smoothness).	4	3	2	1
8. Finished product quality (effectiveness of message, technical quality, etc.).	4	3	2	1
9. Contribution as a team member.	4	3	2	1

Note: This assessment can be used as a peer, self or instructor tool.

By Dave Boyt & Mike Allen



Instructor Resource

In Motion!

Content Outline

1. Principles of Video Production

2. Hardware

- Video Recorders and Players
- Audio Recorders and Players
- Mixing Equipment

3. Production Planning

- Topic Identification
- Story Boarding
- Writing a Script

4. Composition

5. Editing

6. Special Effects

- Transisient
- Wipe
- Spin and Revolve
- Animation

7. Careers in Video Production

Instructional Resources

Bond, A (1974). The Video Handbook. Media Horizons Publishing Co. New York, NY.

Gradius, B. (1981). Directing the TV Commercial Hastings House Publishing Company. New York, NY.

Johnson, C. D. (1992). Communication Systems. Goodheart-Wilcox.

Sanders, M. (1991). Communication Technology: Today and Tomorrow. Mission Hills CA: Glencoe-McGraw-Hill.

Video

Performing on TV (1986). Media, VHS. Magnetic Media Division/3M, St. Paul, MN.

Glossary of Terms

Advertisement - Use of any media to promote a product or idea.

Animation - Creation of the appearance of motion by displaying a sequence of still graphics in rapid sequence.

Back light - Light that goes behind the subject to give the subject a fuller appearance.

Butt edit - (Also known as a jump cut) when one scene sharply ends and the next scene begins with no intermission time between them.

Camcorder - Device for recording video information onto tape.

Claymation - Use of movable material (such as clay) to create the illusion of motion by shooting a series of shots in which the material is moved slightly each time.

Close-up - A shot in which the camera appears to be close to the subject.

Dissolve - When one scene appears to "fade into" the next scene (this is a type of transition that you will not be able to use with the techniques utilized in this TAM).

Dolly - Moving the camera toward or away from the subject.

Dress rehearsal - Final rehearsal before the actual performance, in which lights, costumes, and cameras are in place, but not used.



Editing - Removing or rearranging segments of a videotape.

Emotional appeal - Technique in which emotions of the viewer (fear, greed, anger, humor, etc.) are used to promote a product.

Extreme close-up - Shot in which the camera appears to be very close to the subject - the subject fills the screen.

Fade - Special effect in which the video appears to go from a normal shot to white or black over a period of several seconds.

Fill light - Light used to get rid of unwanted shadows in the background.

Focus - Adjustment of the lens to provide the sharpest image.

Frames per second - Speed with which individual frames are shown. Standard for television is 30 frames per second.

Key light - the main light used to illuminate the subject.

Lens - Curved, transparent device used to bend light. In the camcorder, it focuses the light.

Pan - Pivoting the camera left or right.

Rack focus - Intentionally taking the subject completely out of focus (this is a type of transition technique).

Scene - Portion of a video which occurs at a given place or time, or conveys a single idea.

Script - Written dialog and actions for actors to follow. Special effects: Unusual effects that give visual or audio impact to a message.

Storyboard - A series of sketches that show what the main scenes in a video will look like.

Tilt - Slanting the camera in an upward or downward position.

Transitions - Time between scenes that leads the viewer from one scene to another.

Truck - Moving the camera to the left or right.

VCR - Device used for playing videotapes.

Wide angle - Shot in which the camera appears to be far from the subject - shows the background and area around the subject.

Wipe - A transition that appears as though the next scene is being "unrolled" or overlapped onto the current one (this is a transition that you will not be able to achieve using the techniques in this TAM).

Zoom - A camera operation that allows the field of view to move closer to or farther away from the subject without physically moving the camera.

Safety Factors

- Students using any electrical device (such as lights) should be aware of safety concerns involving the use of electricity.
- On a set, it is easy to have extension cords strung across the floor. They should be placed so that no one will trip over them.
- Extension cords are designed to carry a certain maximum of electricity. Avoid exceeding this limit. For example, four 500 Watt lights may cause a light-duty extension cord to overheat and short out.
- Do not string extension cords together, especially when heavy current draw is involved. Have appropriate length and capacity cords available for students.
- If ladders are used for building sets, hanging lights, or shooting scenes, use extra care: Have someone hold the ladder any time it is being used.

Instructional Suggestions

Motivation

- Show students some of the best tapes other students have done
- Arrange for an exchange of tapes with other schools
- Discuss the Video competition sponsored by MITEA
- Arrange for the local cable company to air finished videos made by students
- Arrange a field trip to a local television studio
- Set up a TV/VCR in the student cafeteria to play student videos
- Give students an opportunity to make a copy of their video to take home
- Show videos at PTO meetings, school board meetings, etc.

Prerequisite Information

- None necessary, although students should preface the study of video communication and technology with the study of how the communication process works. For a basic outline of the process, see the Introduction section of the Missouri Introduction to Communication Technology Guide.

Demonstrations

- Proper handling of video equipment
- Hookup connections between camcorder and VCR
- Make an instructional videotape showing how to use equipment
- Show and discuss videotapes made by other students
- Show effects of light, camera placement, and zoom.

Academic Enrichment

- Arrange for interested students to work part-time at a local TV studio
- Have students videotape other classes: for example, chemistry or physics experiments, speech class, driver's ed.
- Videotape the debate team so that members can view their performance
- Videotape athletic practices & games to help the team view their strengths and weaknesses
- Create an animation on the computer and edit it into a videotape
- Make a documentary on some issue at school (for example an investigative report on what REALLY goes into cafeteria food)

Related TAMS

- Introduction to Communication Technology Guide
 - TAM 14 Video Synchrades
 - TAM 17 Animation
- 1990 Implementation Workshop TAMS
 - TAM 1 Video Synchrades
- 1991 Implementation Workshop TAMS
 - TAM 2 Computer Job Printing/Image Scanning
 - TAM 18 Fiber Optic Communication/Transmitter-Receiver
- Performance Standards Project
 - TAM 3 Telecommunications/Telephony



Assessment/Evaluation Suggestions

- Finished videos show continuity
- Students effectively used lights and camera angles to convey message
- Editing shows an understanding of the process and purpose
- Finished video meets original objectives
- Students can point out advertising techniques used in commercials
- Students demonstrate an understanding of the importance of audience analysis
- Students solve problems involved in developing creative video effects
- Cooperation among students in developing a finished product

Notes: Review the assessment items which are presented throughout the Performance Standards TAMS for ideas which can be adapted for this TAM. You should also refer to the Performance Standards Implementation Handbook for additional assessment examples and ideas.

Videotapes

In assessing the actual videotapes, it should be noted that since this is a learning experience, professional quality is not to be expected. Rather, the videotapes should serve as indicators that the students have done their homework in pre-planning, and have made appropriate use of the technology for their purposes. The videotapes provide an excellent opportunity for the students to take home the finished product to show their parents, which is excellent for public relations. In viewing the videotapes, it should be apparent that the students involved have:

- Identified the audience they wish to reach
- Had a clearly defined message to convey
- Demonstrated familiarity with the equipment (special effects, such as fades, smooth transitions).
- Shown a variety of camera angles and attention to lighting.
- Finished product consistent with storyboard
- Shown teamwork and cooperation.
- Produced events that follow a logical sequence.

Journal

The instructor may desire to have the students keep journals of their experiences. This is an excellent way to encourage the students to reflect on what they have done and what they have learned from the experience. Some of the components that could go into the journal include:

- What did the student do in the activity?
- What was the most important thing the student learned?
- How could the activity be improved?
- What advice would the student give other students about this activity?
- How could the student use what they have learned in the future?
- Would the student be interested in seeking career information in this area?

Portfolio

The portfolio should contain major milestones in the students participation in these activities. Some of the documented milestones include:

- Journal entries
- Storyboards
- Documentation that shows planning of the videos
- Actual videotape footage

Summary

As a communications media, video has a tremendous power to inform, entertain and persuade. An awareness of the techniques used to achieve these goals should make the student a more critical consumer of video. The basic methods of video production are much the same as they were fifty years ago. What has changed are the tools used, and the amount of exposure we have to video in our daily lives. With the basic understanding gained in this TAM, it is hoped that some students will be motivated to explore other areas of video production, and learn to use new tools as they come out: either professionally, or for recreation.



Technology and the Physical World

Goal

The goal of this unit is to explore the basic concepts of applied physics. Three main types of forces will be explored including mechanical, fluid, and electrical.



Mathematics



Communications



Science



Social Studies



Fine Arts



Health



Technology

Performance Standards

- Speculate the future of various areas of physics, including air conditioning, refrigeration, heat pumps, and environmental control.
- Recognize and analyze the potential positive and negative impacts of the increased use of applied physics devices such as air conditioning, refrigeration, heat pumps, and environmental control on the environment.
- Practice all safety procedures when using the tools associated with constructing applied physics projects.
- Comprehend how applied physics technology impacts and affects society and the everyday lives of its citizens.
- List and describe the various applications of applied physics technology, including everyday, specialized, industrial and future uses.
- Develop a design for and solve problems related to constructing a simple applied physics project.
- Communicate orally, visually, and/or in writing the principles of applied physics.
- Demonstrate the ability to work with applied physics components and those associated with its by-products (air conditioning, refrigeration, heat pump, environmental control).
- Define those practices and terms used in and by applied physics devices (such as air conditioning refrigeration, heat pumps, and environmental control).
- Identify the various foundation skills for different career options in applied physics.



Introduction

Technology can be defined as the study of the way humans have developed and used tools to make the things they need. All the tools that people use need energy to operate. The energy may come from animals, the sun, fossil fuels, water, wind, plants, or man. In all tools, this energy is used to produce forces. To understand how tools operate it is important to be able to identify the forces acting in these tools which cause their parts to move or change. A force is a push or pull on an object. Work is done when that push or pull causes the object to move. If you push your hand against your text book and cause the book to move you have done some work. The further you move the book the more work you have done. A crane lifting a large steel I-beam is doing work. When you push your hand against a wall, you are applying a force on the wall. The harder you push the greater the force you apply. In this case the wall doesn't move so no work is done. You have used a lot of energy and may quickly become tired trying to move the wall, but unless the wall moves, no work is done.

In the following activities you will investigate how three different kinds of forces cause things to move. The three forces are: mechanical, fluid, and electrical. Mechanical forces cause objects to move in straight lines or to rotate around an axis.

Mechanical work = **Force applied to the object** X **Distance the object moves**

Mechanical work = **Torque applied to the object** X **Angle through the object turns**

Pressure is the fluid force which makes liquids or gases move.

Fluid work = **Pressure difference** X **Volume moved**

Voltage is the electrical force which makes electrons move and gives electricity the ability to do work.

Electrical work = **Voltage** X **Charge Moved**

Objective Statement

The activities described in the following pages represent samples of activities which can be used to deliver the performance standards on page 1. Many additional activities can and should be used. Extreme care should be taken to connect each activity with appropriate activity objectives as well as with the performance standards. These objectives should be developed by the instructor and should be shared with and made clear to the students.

Work in Mechanical Systems

In the following activities you will see how forces and work are unifying concepts in all tools. As you study each system look for the unifying concept of work in each system.



Integrated Activity Idea

Do an analysis of an athletic movement (a golf swing, a tennis stroke, swimming movement, etc.). How does energy translate into work? How efficient is the human machine?

Objectives

- Define work done by a force in a mechanical tool.
- Explain the relationship between forces and work in a mechanical tool
- Explain how efficiency relates to the input work and output work for a mechanical tool.
- Define work done by a torque in a mechanical tool.
- Demonstrate the ability to measure angles in radians.
- Identify workplace applications where work is done in mechanical tools.

Main Ideas

- Mechanical tools use forces and torque to cause movement and do work.
- Mechanical work is done when a force or torque moves an object.
- Work is done only while the force or torque is being applied by the tool.
- Efficiency describes how well a machine performs work.

Discussion

Mechanical work is done when a force or a torque moves an object. Tools use force and torque to cause movement and thus, to do useful work. The wrench transmits a force to a nut. As the nut turns the wrench does work on the nut. In meshing gears, when one gear drives another, the driving gear does work on the driven gear.

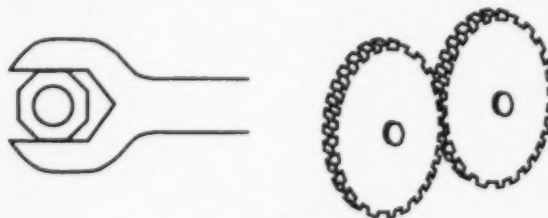


Figure 1 - Wrench & Nut, Gears



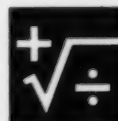
Let's look at a simple example of how a force can produce work. Suppose you were going to lift a 100 pound barbell off the floor. As the barbell rests on the floor gravity is pulling down on the barbell with a force of 100 pounds. The floor must be able to support the barbell so it pushes upward against the barbell with a force of 100 pounds. The barbell just sits there since these forces are equal and in the opposite direction of each other. No work is being done by the barbell or the floor because neither is moving.

As you grab the barbell and begin to lift upward, the force you produce becomes stronger than the force of gravity and the barbell moves upward. As you move the barbell you begin to do work on the barbell. A 100 pound force will cause the barbell to continue to move. To figure out how much work you do on the barbell you need to know the force you used multiplied by the distance you move the barbell. If you lift the barbell a distance of two feet, the work you did on the barbell is equal to the 100 pound force times the two feet.

Mechanical work	=	Force applied to the object	X	Distance the object moves
----------------------------	----------	--	----------	--------------------------------------

Mechanical work	=	100 pounds	X	2 feet
----------------------------	----------	-------------------	----------	---------------

Mechanical work = 200 foot pounds

**Integrated
Activity Idea**

Calculate total amount of work done in a recommended physical workout based on reps, mass, tone, etc.

Activity 1

Using Pulleys

Activities 1 and 2 are designed to help you explore work in mechanical systems. Follow the steps of procedure as outlined.

Part 1 - Single Pulley

1. Set up a single pulley as shown in Figure 1. Attach a weight (W) to the load end of the cord. Make sure to record the value of the weight in your data table.
2. Pass the cord over the top on the wheel of the pulley and attach it to the spring scale. **Instructor Initials**
3. Measure the force it takes to start the weight moving upward at a slow constant speed. This is the input force (P). Record P in the data table.
4. Measure the distance the weight moves (Y) as you move the input cord the distance (X). Record these measurements in your data table.

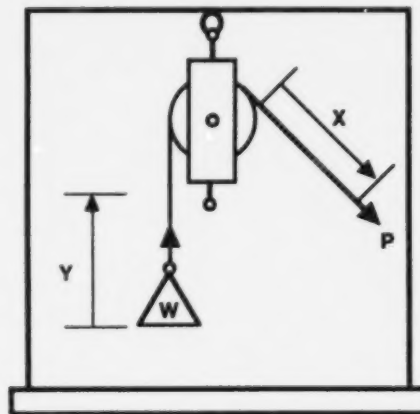


Figure 2 - Single Pulley Setup



Technology Idea

Locate some real world examples of pulley configurations such as a winch on a 4 x 4, on a boat trailer, or a tow truck. Repeat the procedures used in this activity on these "real life" devices. Do the same ratios hold true?

Part 2 - Two Pulleys

1. Arrange the pulleys as shown in Figure 3. Use the same weight as you did in part one. Measure and record the same quantities W , P , Y , X as you did in part one. **Instructor's Initials**

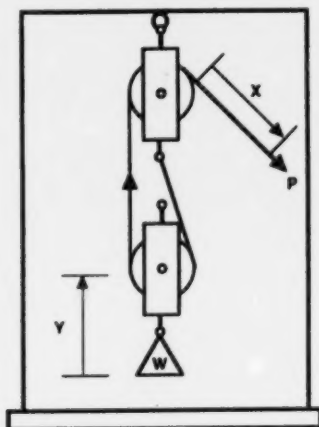
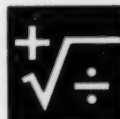


Figure 3 - Two Pulley Configuration



Integrated Activity Idea

Experiment with your pulley setups by changing the diameter of the pulleys. Does this make a difference? If so, what is the effect of pulley size on force?

Part 3 - Three Pulleys

1. Arrange the pulleys as shown in Figure 4. Again measure the quantities and record the quantities W, P, Y, X. **Instructor's Initials**

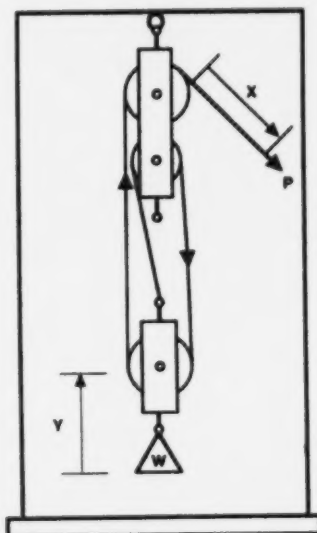


Figure 4 - Three Pulley Configuration



Technology Idea

Based on data gathered in this activity, calculate a pulley configuration which would allow a single student to lift an extremely heavy object (such as one end of an automobile, a trash dumpster, etc.).

Part 4 - The Data Table

Pulley System	Load	Distance Load Moves	Pulling Force	Distance Force Moves	Work In	Work Out	Efficiency
	W	Y	P	X	$P \times X$	$W \times Y$	$\frac{\text{Work In}}{\text{Work out}} \times 100$
Part 1							
Part 2							
Part 3							



Technology Idea

Explore the early beginnings of the use of simple machines for moving objects. How were they developed? What cultural factors facilitated their development? What factors worked against their development?

Part 5 - Calculations, Conclusions and Extensions

1. Calculate the values for each part of the data table. Include the units when you record the number.
2. Does the amount of work In equal the amount of work out? If some work is missing where does it go?
3. What is the pattern that is developing between the number of supporting cords and the pulling force required to raise the weight?
4. What are some advantages of using a multiple pulley system? Are there any disadvantages?
5. Design a multiple pulley system that can lift the weight with only one fifth the pulling force.

Materials Needed

3 pulleys
rope or cord
weight
hooks
spring scale
meter stick



Activity 2

Work Done Using a Winch

A winch is a mechanical device designed to make the job of moving heavy object easier. Often you see a winch mounted on the front of a four wheel drive truck. The winch is placed there to help the truck pull its self out of the mud or any other place where it has gotten stuck. Often a small electric motor is used to turn the gears in the winch to produce a force large enough to move the truck.

The winch, like many other tools, uses its mechanical advantage to take a small force and produce a large force. In this activity you will measure the work done on the winch to cause it to operate and measure the work output. Then you'll find the efficiency of the winch. A winch is made out of several different sized gears. As you look at the gear you can see how they fit together or mesh as they turn. This meshing of gears keeps the gears from slipping past one another as they turn. The force that causes the gear to turn is called torque. A torque is like any other force you have studied. It is a push or pull on a object. Torque produces work when they cause the object to move, but in this case the force causes the object to rotate. A torque is a force that pushes or pulls on an object trying to make it rotate.

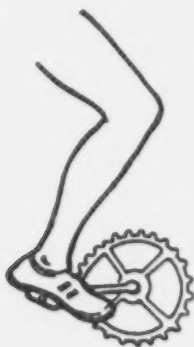


Figure 5 - Bicycle Crank and Pedal

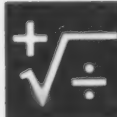
$$\text{Torque} = \text{Force applied} \times \text{Length of arm}$$

When you studied pulleys you measured the amount of the distance an object was moved in a straight line with a ruler. This doesn't work well for an object which turns. For objects that rotate you will need to measure the number of degrees or the angle it has been moved through. The unit of measurement called a radian was invented to help make this measurement. One radian of rotation is equal to turning the gear the distance of one radius of the gear. Look at the diagram below. The gear in the diagram has the radius of two inches. If you turned the gear so the tooth moved two inches, you would have rotated the gear one radian.



Integrated Activity Idea

Write a technical report which presents and discusses the efficiency analyses of some winches which you can locate (boat trailer, tow truck, etc.).



Integrated Activity Idea

Calculate the mechanical advantage which is gained by changing the length of the pedal crank on a bicycle.



Technology Idea

Design and build a human powered tractor for a tractor pull. See TAM 10 the Introduction to Energy and Power Guide.

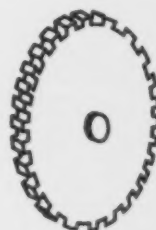


Figure 6 - Gear

If the gear would have had a radius of six inches you would have to turn the gear six inches to rotate it one radian. So what is the big deal about using radians? It turns out that no matter how big or small a gear is if it is rotated one radian it has turned 57.3 degrees. It is much easier to measure in radians than how many 57.3 degrees something has turned. When a gear turns one time it has rotated 6.28 radians.

$$\text{Radians} = \text{Number of turns} \times 6.28$$

If a gear turns ten times, it has rotated 62.8 radians.

The work done on the winch by a torque is equal to the torque times the number of radians it rotated.

$$\text{Work} = \text{Torque} \times \text{Radians}$$

If a ten pound force is applied to a pedal one foot long for ten rotations how much work is put in?

1. Find the torque

$$\text{Torque} = \text{Force applied} \times \text{Length of arm}$$

$$\text{Torque} = 10 \text{ pounds} \times 1 \text{ foot}$$

$$\text{Torque} = 10 \text{ foot pounds}$$

2. Find the radians the pedal turned

$$\text{Radians} = \text{Number of turns} \times 6.28$$

$$\text{Radians} = 10 \text{ turns} \times 6.28$$

$$\text{Radians} = 62.8 \text{ Radians}$$

3. Find the work

$$\text{Work} = \text{Torque} \times \text{Radians}$$

$$\text{Work} = 10 \text{ foot pounds} \times 62.8 \text{ radians}$$

$$\text{Work} = 628 \text{ foot pounds}$$



Integrated Activity Idea

Consult with the math teacher about the relationship between radians and angles.



Activity 3

Using a Winch

Part 1

1. Identify the parts of the winch by using Figure 7.
2. Measure the radius of the winch disk. This measurement is the length of the lever arm (L). $L =$ _____
3. Set up the equipment as pictured in Figure 8.
Instructor's Initials
4. Test your winch by lifting the weight making sure all connections and alignments are correct.
5. Allow the weight to return to its starting position.
6. Place a single, pencil mark on the edge of the winch disk. This mark will be used to count the number of rotations (N) the winch disk makes as you lift the weight.

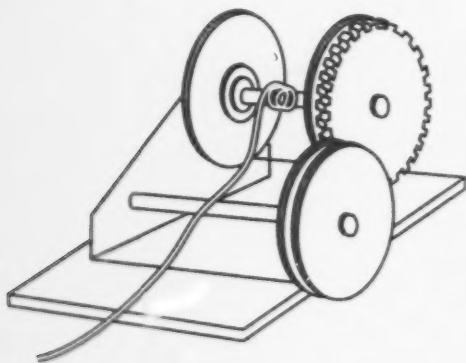


Figure 7 - Winch



Integrated Activity Idea

Make a video which includes footage of as many winches as you can locate (meat packing plant, an industrial site, an engine hoist, a tow truck, etc.). Coordinate with music as appropriate to make it fun as well as informational.

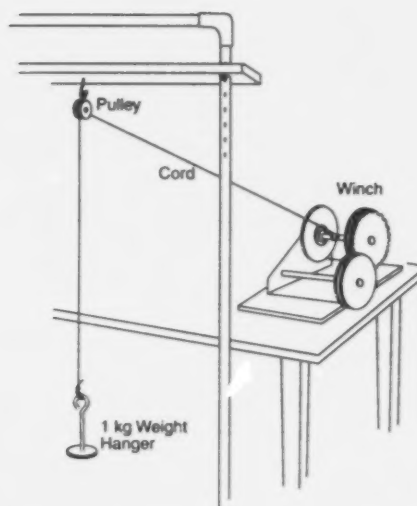


Figure 8 - Setup



Technology Idea

Take this activity a step further by experimenting with the effects of adding multiple pulleys. Expand your chart to include this information. What are some situations in the real world where this exact thing was done to increase the mechanical advantage of a winch?

Part 2

1. Record the value of the weight in the data table.
2. Connect the spring scale to the cord on the winch disk and practice pulling gently with just enough force to lift the weight at a constant speed.
3. Record this pulling force (P) in the data table.
4. Have your partner hold the yard stick next to the load and measure how far the load is lifted when you turn the winch disk enough complete turns to lift the load about 30 inches. Record the number of complete turns and the distance the load was lifted in the data table.
5. Repeat steps 1-4 several times to make sure things are working well.

Weight of Load (lbs.)	Pulling Force (lbs.)	No. of Turns	Distance Load Moved (ft.)
W	P	N	Y



Part 3 - Calculations, Conclusions and Extensions

1. Calculate the torque.

Torque = Pulling force (P) X Length of the lever arm (L)

Torque = _____ Foot pounds

2. Find the distance in radians the winch disk turned while you were lifting the weight.

Radlans = Number of turns (N) X 6.28

Radlans = _____

3. Find the amount of work you put in to the winch.

Work^{In} = Torque X Radlans

4. Find the amount of work the winch put out.

Work Out = Weight of Load (W) X Distanced Moved (Y)

Work Out = _____

5. Calculate the winch efficiency

% Efficiency = Work Out / Work In X 100

% Efficiency = _____

6. Does the amount of work in equal the amount of work out? If some work is missing where does it go?
7. A fishing reel is a type of a winch, but how is it different from the winch you just studied? Why is it made this way?

Materials Needed

stand for pulley

pulley

weight

winch (available from any science or technology supplier)

cord

C-clamp

meter stick

Work in a Fluid System

Objectives

- Define work done by a force in a fluid system.
- Explain the relationship between work, volume and pressure difference.
- Identify tools that use pressure differences to produce work.



Technology Idea

Take a pump apart to see how it is constructed. This can be an automobile brake system master cylinder, a squirt gun, a water pump, etc. How do they work? What features do all of these devices have in common?

Main Ideas

- Fluids are any substance that will take the shape of their container.
- Fluids move from high pressure to low pressure.
- Fluid systems are either open or closed.
- Work happens in a fluid system when fluid pressure moves a volume of fluid.

Discussion

Fluid work is done when a pressure difference causes a liquid or gas to move. The wind blows because the sun heats the surface of the earth differently from place to place. Where the sun heats the air and causes it to rise, an area of low pressure is formed. Areas around this low pressure area seem to have high pressure and the air moves from the high to low areas causing the wind to blow. The bigger the difference between the areas the harder the wind will blow. Fast blowing winds can cause a great deal of damage or do a lot of work on a building. A tornado is an area of very low pressure in which winds blow inward in the excess of 300 mph. Fluids act very much the same way.



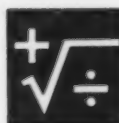
Figure 9 - Weather Map Showing High & Low Pressures & Direction of Winds

As a pump causes an area of high pressure the fluid will flow away from it to an area of low pressure. There are two general types of fluid systems.

- **Closed systems** - reuse the fluid or air over and over.

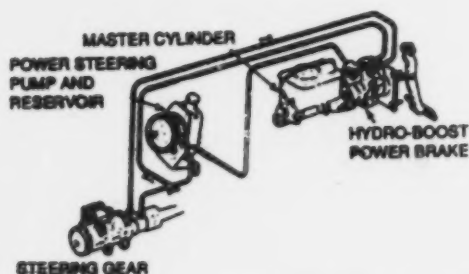


- **Open Systems** - do not recycle the fluid or air. The brake system on a car is a closed system. The brake fluid is reused every time the break pedal is pressed. The force from your leg causes an area of high pressure in the master cylinder and the fluid moves. When you let off the brakes, the fluid returns to the master cylinder to be reused. An oxyacetylene torch outfit is an example of an open system. The tanks are filled with high pressure gases. The fluid moves away from the high pressure and is forced into the body of the torch and out into the atmosphere. The gases are consumed and are not reused.



Integrated Activity Idea

Calculate the work accomplished by the electric motors and syringes in the Robotics TAM (TAM 9).



Courtesy of Wagner Division, Cooper Industries, Inc.

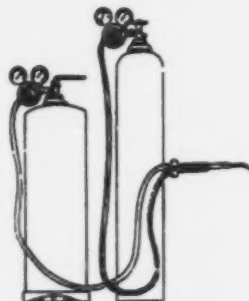


Figure 10 - Closed & Open Fluid Systems

In mechanical systems work occurs when a force moves something a distance. Likewise, in a fluid system a pressure produces a force which causes a volume of fluid to move. Regardless of the fluid system, the formula for determining the amount of work is the same.

$$\text{Work} = \text{Pressure difference} \times \text{Volume moved}$$

For example, let's consider the work done by a pump as it lifts water from a lake to a tank on a hill. Water is lifted through a vertical distance of H feet. The pressure on the water at the tank is equal to the air pressure; the pressure on the water at the pump is equal to the air pressure plus the pressure that comes from the weight of the column of water H feet high. The pressure difference is equal to the pressure that comes from the weight of the column of water H feet high. In our sample problem, the pump must lift the water 100 feet. The tank has a volume of 500 cubic feet of water. To find out how much work the pump must do to fill the tank, we must first find out the pressure difference between the pump and the tank.

1. Find pressure difference.

Pressure difference is equal to the column of water 100 feet high. The pressure is equal to the density of water (62.4 lb/ft^3) times the height of the column.

$$\text{Pressure} = 62.4 \text{ lb/ft}^3 \times 100 \text{ ft}$$

$$\text{Pressure} = 6240 \text{ lb/ft}^2$$



Integrated Activity Idea

Do a historical investigation into the development of the syringe. How did it get started? What were the early applications? Was it developed from something else and then adapted to medicine?

2. Find volume.

The volume of the water moved is 500 ft³

3. Find work.

Work = Pressure difference X Volume moved

Work = 6240 lb/ft² X 500 ft³

Work = 3,120,000 ft lbs

The amount of work done by the pump to move 500 cubic feet of water 100 feet up the hill to the tank is 3,120,000 foot pounds.



Activity 1

Work Done by a Pump

Part 1

1. Set up the pump system as shown in Figure 11. Check all hose connections to make sure they are tight and will not leak water.
2. Fill the bottom reservoir with five gallons of tap water.
3. Connect the pump's motor to the power supply.
4. Operate the pump until the upper container has filled to the four gallon mark.
5. Measure the height from the floor to the bottom of upper container.

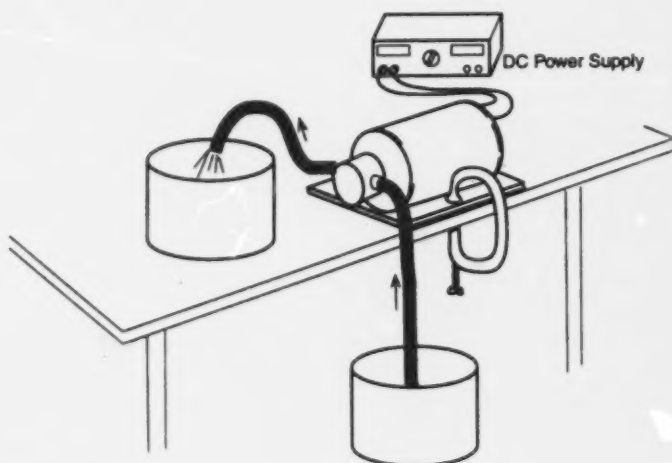


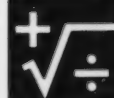
Figure 11 - Pump System

Part 2 - Calculations, Conclusions and Extensions

1. Find pressure difference.

Pressure difference is equal to the column of water H feet high. The pressure is equal to the density of water (62.4 lb/ft^3) times the height of the column.

$$\text{Pressure} = 62.4 \text{ lb/ft}^3 \times H \text{ ft}$$



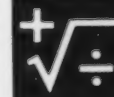
Integrated Activity Idea

Measure and calculate the work done by an automobile's water pump.



Technology Idea

Take this activity a step further to experiment with some real life applications like the water pressure from a city water tower, the power of flood water, a sump pump in a basement, etc.



Integrated Activity Idea

Estimate the amount of work needed to change water levels in the Panama Canal to allow for boat passage.



**Integrated
Activity Idea**

Locate the book "How Things Work." Look up information on devices which have been designed to move fluids. Then present your findings in technically correct and interesting form to the class. You might want to bring samples of materials or small machines to demonstrate or illustrate your presentation.

Pressure = _____ lb/ft²

- 2 Find volume. In this problem the volume of water was measured in gallons and must be changed into cubic feet. To do this, multiple the number of gallons times .134 cubic feet per gallon.

The volume of the water moved is .536 ft³

3. Find work.

Work = Pressure difference X Volume moved

Work = _____ lb/ft² X .536 ft³

Work = _____ ft lbs

4. What happens to the amount of work required if the height of the tank was twice as high?
5. How does the amount of work required change if instead of water the pump moved light oil (density less than water)?
6. If it takes a lot of work to get the water pumped up the hill to the tank, why are water tanks for cities so far above ground?

Materials Needed

water pump (available from scientific supply houses or home stores)
hose
C-clamp
DC power supply corresponding to motor specifications.
2 buckets
stop watch
meter stick
water



Activity 2

Work Done by a Hydraulic Cylinder

Discussion

A piston acts like a movable plug in a hollow cylinder. A higher pressure on one side of the piston causes the piston to move towards the lower pressure side. As the piston is moved work is done. To calculate the amount of work you need to know the pressure difference on the opposite sides of the piston and the volume of fluid moved. In Figure 12 a hollow cylinder with a diameter of six inches or 1/2 foot is pictured.

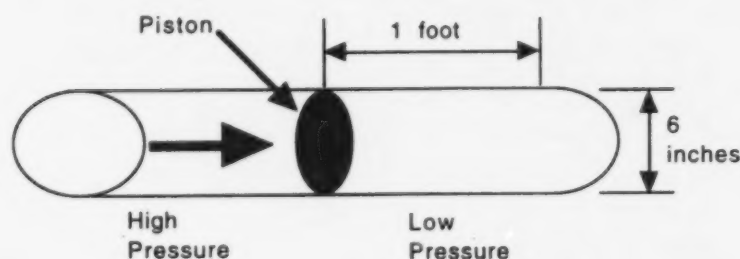


Figure 12 - Cylinder and Piston

A piston is going to move to the right because high pressure on the left will cause the piston to move from high to low. In this sample problem a high pressure of 12 lb/ft² is on the left and a low pressure of 2 lb/ft² is on the right. The piston moves one foot to the right.

1. Find the pressure difference.

$$12 \text{ lbs/ft}^2 - 2 \text{ lbs/ft}^2 = 10 \text{ lbs/ft}^2$$

The pressure difference is 10 lb/ft².

2. Find the volume of fluid moved.

To find the volume of the fluid moved you need to know the surface area of the piston and the distance the piston moves.

$$\text{Area of a circle} = \pi \times R^2$$

$$\text{Surface area of the piston} = 3.14 \times (.25 \text{ ft})^2$$

$$\text{Surface area} = .19625 \text{ ft}^2$$

$$\text{Volume of fluid} = \text{Surface area} \times \text{Distance moved}$$

$$\text{Volume of fluid} = .19625 \text{ ft}^2 \times 1 \text{ foot}$$

$$\text{Volume of fluid} = .19625 \text{ ft}^3$$



Technology Idea

Explain how an internal combustion automobile engine works. You might want to build the Sterling Engine presented in the Energy and Power Guide - Energy Conversions TAM.



Technology Idea

Develop an illustrated systems diagram of an automobile's brake system. Then develop a working model using actual components. Mount them to a large sheet of plywood complete with cables so the working model can be used to help other students see how the braking system works.

- Find the amount of work done.

Work = Difference in pressure X Volume moved

Work = 10 lb/ft² X .19625 ft³

Work = 1.9625 ft lbs

Part 1

- Set up the pump system as shown in Figure 13. Check all hose connections to make sure they are tight and will not leak water.
Instructor's Initials
- Remove one of the syringes from the hose and push plunger of the other syringe to its in position.
- Draw water into the system by placing the tube in a cup of water and pulling out on the plunger of the syringe.
- Push the plunger of the unattached syringe to its in position and connect it to the hose. You will want as little of air in the system as possible.

Part 2

- Move plunger A in one inch. How far does plunger B move? Record in data table.
- Place a one pound weight on top of plunger A. How much weight does it take on plunger B to balance out the force from A. Record in data table.

Part 3

- Repeat parts one and two but this time use two different sized syringes. Record results in data table.

Part 4

- Repeat parts one and two but this time change syringe A and B.

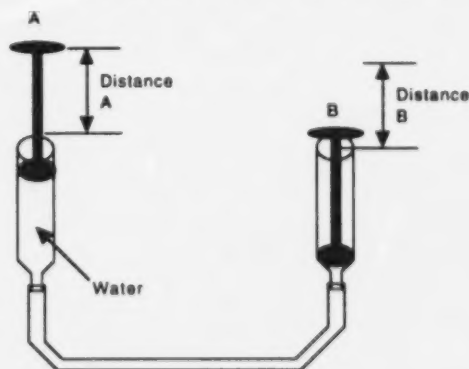


Figure 13 - Pump System

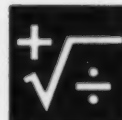


Integrated Activity Idea

Conduct a work and force analysis of a syringe robot. (See TAM 9, Activity 2.)

**Part 5 - Calculations, Conclusions and Extensions****Data Table**

	Distance	Distance	Weight	Weight
Part	A	B	A	B
1				
2				
3				
4				
5				

**Integrated
Activity Idea**

Develop a graph to display
your findings.

1. Is there a pattern that develops between the size of the syringe and the distance the plunger moves?
2. When the syringes are the same size, do they support the same weight? Why?
3. Is the efficiency of the system 100%? What are some ways you could improve efficiency?
4. Is this an open or closed system?
5. What are some examples of tools that use pistons to do work?
6. Use the formulas found in work done by a pump to calculate the work done in parts two and three.



Technology Idea

Develop an illustrated systems diagram of an automobile's brake system. Then develop a working model using actual components. Mount them to a large sheet of plywood complete with cables so the working model can be used to help other students see how the braking system works.

- Find the amount of work done.

Work = Difference in pressure X Volume moved

Work = 10 lb/ft² X .19625 ft³

Work = 1.9625 ft lbs

Part 1

- Set up the pump system as shown in Figure 13. Check all hose connections to make sure they are tight and will not leak water.

Instructor's Initials

- Remove one of the syringes from the hose and push plunger of the other syringe to its in position.
- Draw water into the system by placing the tube in a cup of water and pulling out on the plunger of the syringe.
- Push the plunger of the unattached syringe to its in position and connect it to the hose. You will want as little of air in the system as possible.

Part 2

- Move plunger A in one inch. How far does plunger B move? Record in data table.
- Place a one pound weight on top of plunger A. How much weight does it take on plunger B to balance out the force from A. Record in data table.

Part 3

- Repeat parts one and two but this time use two different sized syringes. Record results in data table.

Part 4

- Repeat parts one and two but this time change syringe A and B.

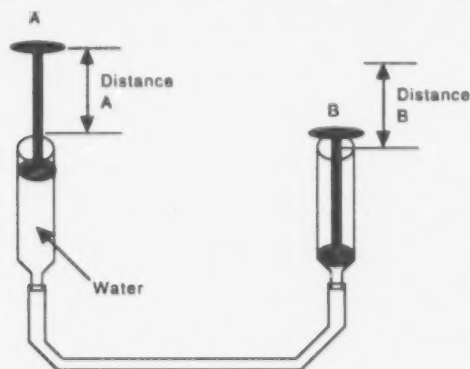
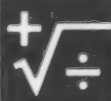


Figure 13 - Pump System

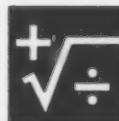


Integrated Activity Idea

Conduct a work and force analysis of a syringe robot. (See TAM 9, Activity 2.)

**Part 5 - Calculations, Conclusions and Extensions****Data Table**

	Distance	Distance	Weight	Weight
Part	A	B	A	B
1				
2				
3				
4				
5				

**Integrated
Activity Idea**

Develop a graph to display
your findings.

1. Is there a pattern that develops between the size of the syringe and the distance the plunger moves?
2. When the syringes are the same size, do they support the same weight? Why?
3. Is the efficiency of the system 100%? What are some ways you could improve efficiency?
4. Is this an open or closed system?
5. What are some examples of tools that use pistons to do work?
6. Use the formulas found in work done by a pump to calculate the work done in parts two and three.

Work in Electrical Systems

Objectives

1. Describe work in electrical systems in terms of voltage and charge moved.
2. Describe units of voltage and charge.
3. Identify the effects of work done in electrical systems.
4. Identify workplace applications where work is done with electrical tools.

Main Ideas

1. Voltage is a force that moves electrical charge.
2. The rate of movement of electrical charge is current.
3. Efficiency of electrical tools is always less than 100%.
4. The unit of electrical work is the joule.

Discussion

Electrical work is done when a voltage moves an electric charge. The voltage is the push behind the electrons which make up the charge. Voltage acts much like fluid pressure. Electrons which carry an electric charge move from areas of high voltage to areas of low voltage. The greater the voltage difference, the greater the force behind the charge to move. The charge is made up of electrons, the greater the charge the larger the number of electrons. Electrons only move over special pathways called circuits.

What is electrical charge? Electrical charge is made up of the energy of electrons. Since electrons are very small, it takes a huge number to amount to anything. Scientists developed the coulomb unit of measure to account for the large groups. A coulomb has 6.25 billion electrons.

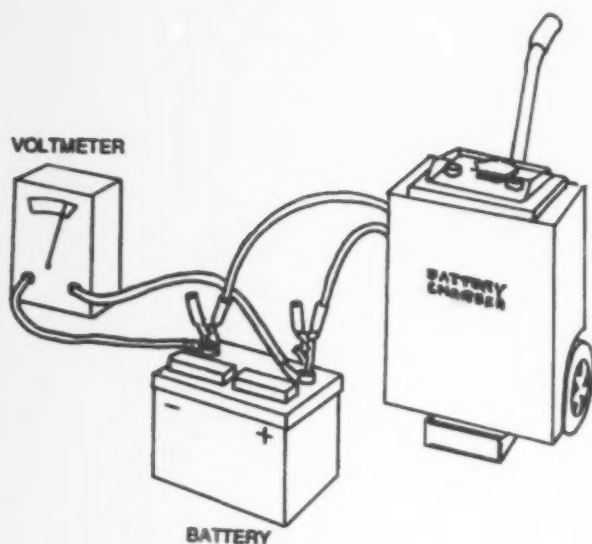


Figure 14 - Car Battery and Charger

Let's look at a sample problem of how work is done to charge a car battery. Suppose you left your car lights on and your car battery has gone dead. To recharge the battery you must force electrons in to the battery. You would use a 12-volt voltage difference to force about 400,000 coulombs of electrical charge.

Electrical work	=	Voltage	X	Charge Moved
Electrical work	=	12 Volts	X	400,000 Coulombs
Electrical work	=	4,800,000 Joules		

The car battery now has stored 4,800,000 joules of electrical work that can be used by you to start the car. As you try to start your car the stored work is used by the electric starter. The battery discharges and becomes weaker as the electrical work is used.

It is difficult to measure or count coulombs of electrons so scientists usually measure electrical charge by its current. Current is the measure of how much electrical charge is moved per second. Current can be easily measured in amperes (amps) with an ammeter, so we don't have to worry about all that counting. If one amp of current flows for one second, one coulomb of charge was moved.

Activity 1

Work Done by a Motor



Technology Idea

Calculate the work and efficiency of motors which are located throughout the school. Are the motors appropriate for their applications?

1. Set up the system as shown in Figure 15. Attach a weight (W) to the load end of the cord. Make sure to record the value of the weight in your data table.
2. Pass the cord over the single pulley attached to the support frame.
3. Attach the other end of the cord to the take up drum on the motor start. Check all knots and connections. **Instructor's Initials**
4. By hand, turn the motor shaft to take out any slack in the cord.
5. Connect the power supply, voltmeter, ammeter, switch and motor as shown in Figure 16.
6. Set the power supply on its lowest setting and turn on, and close switch.
7. Slowly increase voltage until the cord begins to turn slowly and has been taken up.
8. Open switch and allow the weight to return to the start position.
9. Measure distance (D) to be two feet and mark with tape on support stand. Make sure to record the value of the distance in your data table.
10. The time interval (T) will be measured as the weight travels up between the two tape marks on the support stand. Make sure to record the value of the time in your data table.
11. Both the voltage (V) and the current (I) must be noted as the motor lifts the weight. Make sure to record the value of the voltage and current in your data table.

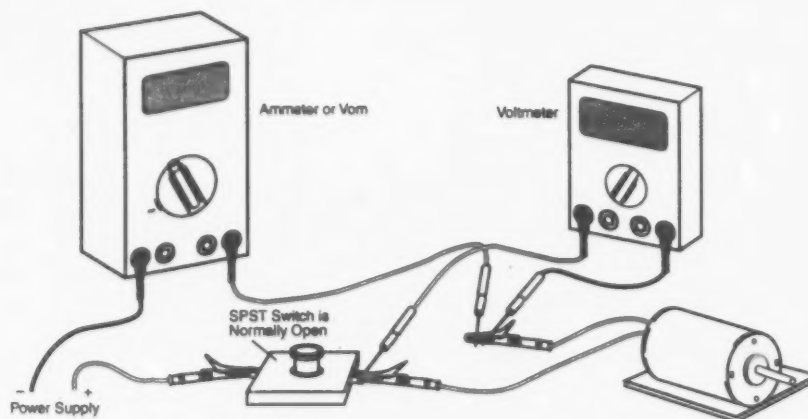


Figure 15 - System Setup

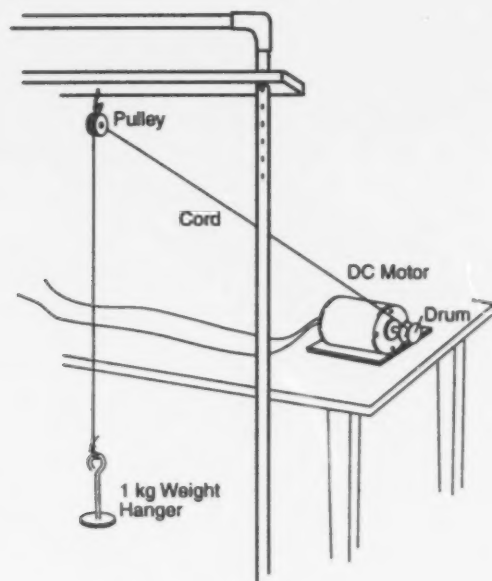
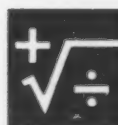


Figure 16 - Motor Setup



Integrated Activity Idea

Develop a graph to display your findings.

Part 1 Data Table

Work Done by a Motor - Data Table

Weight Raised in Pounds (W)	Height in Feet (H)	Time in Seconds (T)	Voltage (V)	Current (I)	Work IN $V \times I \times T$	Work OUT $W \times H$



Technology Idea

Experiment with multiple pulley setups. Expand your table to include that information. Find some real world examples of where this exact thing has been done to increase the mechanical advantage.

Part 2 Calculations, Conclusions and Extensions

1. Calculate the values for each part of the data table. Include the units when you record the number.
2. Try to compare the amount of work in and the work out.
3. How could you increase the efficiency of this system?

4. How could a system like this one be used in a factory?
5. How could you use a multiple pulley system from the mechanical activities to increase the lifting force?

Materials Needed

DC motor (12 V)
rope
weight hanger stand
meter stick
stop watch
volt meter
ammeter
connecting leads
switch



Activity 2

Work Done by an Electric Pump

In Activity 1 of the Work In a Fluid System section of this TAM you studied the work done by a force in a fluid system. In this activity you will expand upon the setup and measure the work the electrical system does and the work done on the fluid.

Part 1

1. Set up the system the same way you did for the fluid activity (Figure 11, pg. 17).
2. Connect the power supply, voltmeter, ammeter, switch and motor as shown in Figure 16. **Instructor's Initials**
3. The time interval (T) will be measured as the water is pumped. Make sure to record the value of the time in your data table.
4. Both the voltage (V) and the current (I) must be noted as the motor turns the pump. Make sure to record the value of the voltage and current in your data table.



Integrated Activity Idea

Do an analysis of the cardiovascular system using the concepts learned in this activity. Develop an illustrated chart which compares an electrically operated fluid pump of your choice (for example a sump pump in your basement) with your heart and nervous system. Attempt to make direct comparisons between the components in the 2 systems.

Part 2 Calculations, Conclusions and Extensions

1. Find pressure difference for the column of water.

Pressure difference is equal to the column of water **H** feet high. The pressure is equal to the density of water (62.4 lb/ft³) times the height of the column.

$$\text{Pressure} = 62.4 \text{ lb/ft}^3 \times H \text{ ft}$$

$$\text{Pressure} = \underline{\hspace{2cm}} \text{ lb/ft}^2$$

2. Find volume. In this problem the volume of water was measured in gallons and must be changed into cubic feet. To do this, multiple the number of gallons times .134 cubic feet per gallon.

The volume of the water moved is .536 ft³

3. Find work.

$$\text{Work} = \text{Pressure difference} \times \text{Volume moved}$$

$$\text{Work} = \underline{\hspace{2cm}} \text{ lb/ft}^2 \times .536 \text{ ft}^3$$

$$\text{Work OUT} = \underline{\hspace{2cm}} \text{ ft lbs}$$

Data Table

Work Done by an Electric Pump - Data Table

Weight of Water Raised in Pounds (W)	Height in Feet (H)	Time in Seconds (T)	Voltage (V)	Current (I)	Work IN $V \times I \times T$	Work OUT $W \times H$

1. Calculate the values for each part of the data table. Include the units when you record the number.
2. Try to compare the amount of work in and the work out
3. How could you increase the efficiency of this system?
4. How could a system like this one be used in a factory?

Materials Needed

water pump (available from scientific supply houses or home stores)
 hose
 C-clamp
 DC power supply corresponding to motor specifications
 2 buckets
 stop watch
 meter stick
 water



Activity 3

Refrigerators/Air Conditioners/Heat Pumps

Often Science experiments seem to lack a connection to the real world. You do the lab, get the results, answer the questions and then say so what. The labs or activities that you did in the rest of the TAM may have seemed that way. The following lab or activity will bring the pieces of the previous activities together by examining a common household device the refrigerator. The refrigerator is a complex closed system which is composed of three main subsystems working together. The subsystems are the compressor, condenser, and evaporator. Identify the activities that relate to each of these subsystems. The compressor is made up of an electric motor and a pump. The compressor moves the refrigerant gas in the system towards the condenser. As the gas moves it is placed under increasing pressure. The increasing pressure causes the gas to change phase, that means that the gas condenses to become a liquid. When the change occurs the gas must give off heat, making the condenser warm.



Technology Idea

Explore career opportunities in heating and air conditioning related areas. What type of background and training do these jobs require. Consult the Dictionary of Occupational Titles (D.O.T.) and visit with an employer at a HVAC company for additional information.

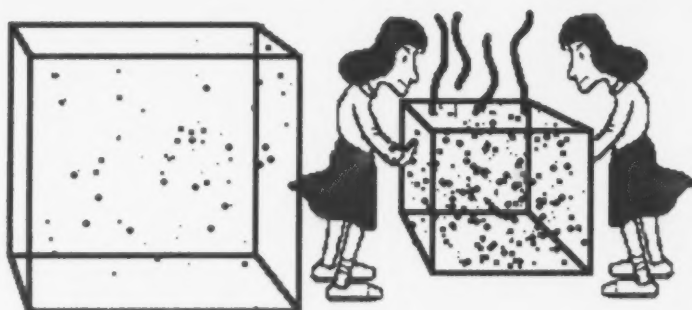


Figure 17 - Gas Pressure Change

The condenser is at the back of the refrigerator, and the heat flows into the air around the refrigerator. The liquid flows out of the condenser into the evaporator through an expansion valve. The expansion valve acts much like the nozzle on top of a spray can. As the liquid passes through the expansion valve it evaporates back into a gas. As the liquid changes phase it takes in heat from the air. The evaporator is inside the refrigerator and heat flows into the evaporator making the inside of the refrigerator cold.

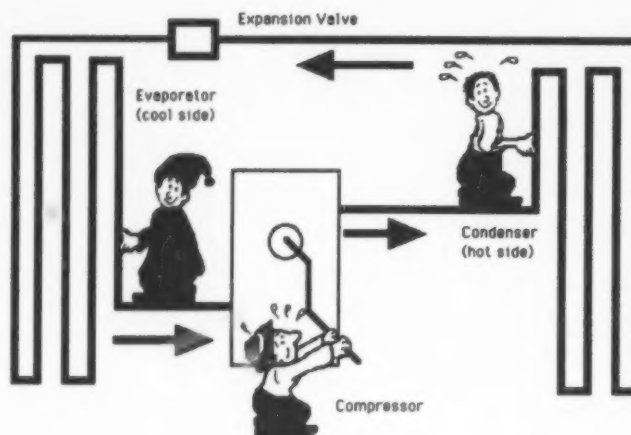


Figure 18 - Refrigeration System

Procedure

1. Visit your local appliance repair shop and obtain an old but working refrigerator.
2. Have the repair man remove the refrigerant in an environmentally safe manner.
3. Disassemble the refrigerator and identify the three subsystems discussed above.
4. Mount and reconnect the system on a display board, a 4 x 8 sheet of plywood would work fine. **Instructor's Initials**
5. Once the system is reconnected, check the joints for leaks and then have the repair shop recharge the system.
6. You can now operate the system in a controlled manner to take measurements and determine efficiency.



Integrated Activity Idea

Write a technical report describing how a heat pump works. Design your report such that it can be clearly understood by non-technical people.

Going Further

- What happens to the efficiency of the system when the condenser is cooled with a fan? How about ice?
- How is the temperature regulated inside the refrigerator?
- How could you use the system to heat instead of cool?
- Why do they often bury the evaporator coils of a heat pump underground?



Assessment

Scoring Rubric for Unit 2, Activity 2 - Work Done by a Hydraulic Cylinder

Performance Standard	Wgt %	Exemplary 2 pts.	Acceptable 1 pt.	Not Yet Acceptable 0 pts.	Sub total
I. Creative Thinker					
Speculate the future of various areas of physics, including air conditioning, refrigeration, heat pumps, and environmental control.	x.5	Student locates and uses 3 sources of information on the future use of hydraulic cylinders.	Student locates and uses 1 source of information on the future use of hydraulic cylinders.	Student does not locate and/or use any information on the future use of hydraulic cylinders.	2 x .5 = 1
II. Critical Thinker					
Recognize and analyze the potential positive and negative impacts of the increased use of applied physics devices such as air conditioning, refrigeration, heat pumps, and environmental control on the environment.	x1	Student conducts research of local environments (3 sources) using hydraulics; resulting technical memo has no errors.	Student conducts research of local environments (1 source) using hydraulics and/or resulting technical memo has 1-3 errors.	Student does not conduct proper research of local environments (not applicable sources or technical memo has more than 3 errors).	2 x 1 = 2
III. Contributing Citizen					
Practice all safety procedures when using the tools associated with constructing applied physics projects.	x2	Student practices all safety procedures of the hydraulic activity at all times and encourages others to do so.	Student practices all safety procedures at all times.	Student does not practice all safety procedures at all times.	2 x 2 = 4
Comprehend how applied physics technology impacts and affects society and the everyday lives of its citizens.	x.5	Student orally describes 3 global hydraulic applications that have affected him/her.	Student orally describes 1 global hydraulic application that have affected him/her.	Student does not correctly describe global hydraulic applications that have affected him/her.	2 x .5 = 1
IV. Self-Directed Learner					
List and describe the various applications of applied physics technology, including everyday, specialized, industrial, and future uses.	x1	Student lists 5 applications of hydraulics in their community (from various sources).	Student lists 3 applications of hydraulics in their community (from various sources).	Student lists less than 3 applications of hydraulics in their community or uses only one source.	2 x 1 = 2
V. Problem Solver					
Develop a design for and solve problems related to constructing a simple applied physics project.	x1	Student designs and solves problems for the hydraulic assignment with limited assistance from others (less than 3 assistance situations).	Student designs and solves problems for the hydraulic assignment with average assistance from others (3-5 assistance situations).	Student designs and solves problems for the hydraulic assignment with excessive assistance from others (more than 5 assistance situations).	2 x 1 = 2
VI. Effective Communicator					
Communicate orally, visually, and/or in writing the principles of applied physics.	x1	Student presents an illustrated discussion on the principles of the hydraulic assignment and meets 90% of the preset criteria.	Student presents an illustrated discussion on the principles of the hydraulic assignment and meets 70% of the preset criteria.	Student presents the discussion and meets less than 70% of the preset criteria or does not present the illustrated discussion.	2 x 1 = 2
VII. Quality Producer					
Demonstrate the ability to work with applied physics components and those associated with its by-products (air conditioning, refrigeration, heat pump, environmental control).	x2	Student demonstrates mastery of the hydraulic activity with limited assistance from others (less than 3 situations of assistance).	Student demonstrates mastery of the hydraulic activity with average assistance from others (3-5 situations of assistance).	Student demonstrates mastery of the hydraulic activity with excessive assistance from others (more than 5 assistance situations) or does not complete activity.	2 x 2 = 4
VIII. Technical Foundations					
Define those practices and terms used in and by applied physics devices (such as air conditioning, refrigeration, heat pumps, and environmental control).	x.5	Student submits data gathering assignment that correctly defines practices and terms with a 90% accuracy rate.	Student submits data gathering assignment that correctly defines practices and terms with a 70% accuracy rate.	Student submits data gathering assignment that correctly defines practices and terms with less than a 70% accuracy rate.	2 x .5 = 1
Identify the various foundation skills for different career options in applied physics.	x.5	Student describes (orally or written) 3 foundation skills required for a career in hydraulics.	Student describes (orally or written) 1 foundation skill required for a career in hydraulics.	Student does not effectively/ correctly describe foundation skills required for a career in hydraulics.	2 x .5 = 1

Total: 20 out of 20 Possible

Essay Questions

1. You are to design a mechanical pulley system to lift a certain widget that weighs 100 pounds. Will it be more efficient (less input force, P) to use a single or multiple pulley system? Explain your answer.
2. Briefly describe the relationship between the radius of the gear and amount of leverage (or torque) generated.
3. When using a winch to perform work, does the "work in" equal the amount of "work out?" Explain your answer.
4. Define "open" and "closed" fluid power systems. What are advantages and disadvantages of each?
5. List and explain the components of a refrigeration system.



Name _____

Affective Self and Peer Assessment

For each of the criteria, assign a rating to each member of the class (including yourself) on a scale of 4 - 0
(4 = excellent, 3 = good, 2 = average, 1 = poor, 0 = unsatisfactory.)

	Student A	Student B	Student C
Initiative (ability as a self-starter, self motivated)			
Use of time (consistently on task, productive, efficient)			
Reliability (regular attendance, carry tasks through to completion)			
Work quality (tasks and operations were well done)			
Idea quality (good problem solving skills and ideas)			
Ability to work with others (ability to share tasks, contributing team member)			
Overall knowledge of applied physics concepts			
TOTALS			

Note: See end of individual activities for additional assessment and focus questions

Performance Assessment Rubric

- 4 = Excellent** (student successfully completes activity & displays mastery of subject/content/skill)
- 3 = Good** (student completes activity with good quality/knowledge of skill)
- 2 = Needs Improvement** (student completes activity without demonstrating mastery of subject matter or activity performance requirements)
- 1 = Not Acceptable** (student does not yet successfully complete the activity, needs additional work)

Student demonstrates ability to:

1. Illustrate physics concepts with real world examples.	4	3	2	1
2. Calculate Information using physical science formulas.	4	3	2	1
3. Define, calculate and illustrate concepts such as force, work and energy.	4	3	2	1
4. Problem solve new ways of configuring experiments to explore different variables.	4	3	2	1
5. Set up experiments and equipment in a safe and functional manner.	4	3	2	1
6. Measure accurately.	4	3	2	1
7. Distinguish between an open and closed fluid system.	4	3	2	1
8. Explain how an automobile's brake cylinder works using physical science concepts.	4	3	2	1
9. Think of ways to improve the efficiency of various common physical devices.	4	3	2	1
10. Identify the mechanical, fluid and electrical components in a refrigeration system.	4	3	2	1
11. Clearly explain how a refrigeration system works.	4	3	2	1

Note: This assessment can be used as a peer, self or instructor tool.



NOTES

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Instructor Resource

Technology and the Physical World

Content Outline

1. Basic Machines
2. Power Transmission Types
 - Fluid
 - Mechanical
 - Electrical
3. Basic Concepts
 - Efficiency
 - Power
 - Work
 - Friction
 - Mechanical Advantage
 - Torque
 - Pressure
4. Mathematical Formulas & Calculations
5. Technological Applications

Instructional Resources

Books

Conceptual Physics (1992) Addison-Wesley Publishing Company
 Bohn, R. C., MacDonald, A. J. (1970). Power: Mechanics of Energy Control.
 Bloomington, IL: McKnight & McKnight Publishing. ISBN #87345-486-39
 Glock, J., McQueen R. A., Towler, A. (1989). Energy Systems - Laboratory Activities. Austin, TX: University of Texas at Austin Extension Instructional and Materials Center, Division of Continuing Education.
 Macaulay, D. (1988). The Way Things Work. Boston, MA: Houghton Mifflin.
 Introduction to Energy and Power Technology Guide, Jefferson City, MO: DESE.

Organizations

Center for Occupational Research and Development (CORD), 601 C Lake Air Drive, Waco, Texas 76710
 Agency for Instructional Technology (AIT), Box A, Bloomington, Indiana 47402

Glossary of Terms

Closed system - a system that reuses the fluid or air over and over.
Coulomb - a unit of measure to account for the large groups of electrons. A coulomb has 6.25 billion billion electrons.
Foot-pound - unit of measure for work, equal to the amount of force needed to move a 1 lb. load a distance of 1 foot.
Joule - the unit of electrical work.
Mechanical forces - cause objects to move in straight lines or to rotate around an axis. Mechanical work equals force applied to the object times the distance the object moves. Mechanical work also equals the torque applied to the object times the angle through which the object turns.



Power - the amount of work done in a given period of time.

Pressure - the fluid force which makes liquids or gases move. Fluid work equals pressure difference times volume moved.

Open system - a system that does not recycle the fluid or air.

Radian of rotation - equal to turning the gear the distance of one radius of the gear.

Torque - a twisting force.

Voltage - the electrical force which makes electrons move and gives electricity the ability to do work. Electrical work equals voltage times charge moved.

Work - generally defined as distance moved as a result of applied force.

Safety Factors

- Laboratory safety is important and should be stressed. Activities require the use of electrical power supplies and all connections and wires should be in good condition.
- Exercise caution when lifting heavy objects with pulleys.

Instructional Suggestions

Motivation

- Arrange for field trips to a setting where students can observe the various types of "work" in action.
- Display student work and reports.
- Have students identify and connect with as many "real life" devices as possible.

Prerequisite Information

- Basic lab skills involving safety and setup.
- Some basic background in physics will be useful.
- Some basic background in mathematics will be useful.

Demonstrations

- Each of the basic setups should be demonstrated.

Academic Enrichment

- Activities in this TAM are very science oriented and may be used in the science classroom. Encourage students to share knowledge of technology as it relates to science.
- Have students interact with language arts instructor to implement communication and writing skills highlighted in TAM.

Related TAMS

- Introduction to Energy and Power Technology Guide
 - TAM 6 Physics Made Useful
 - TAM 10 Fundamentals of Mechanical Power Transmission
 - TAM 18 Using Electric Instruments
- 1991 Implementation Workshop
 - TAM 20 The Human Engine
- Performance Standards Project
 - TAM 11 Basic Electronics

Assessment/Evaluation Suggestions

- Interact with the students as they proceed through TAM to check for understanding.
- Have students check for authenticity of activity by having them relate activities to personal experiences and observations.
- Evaluate processes involved in completing activities not just final projects.
- Encourage students to self evaluate their performance.
- Evaluate students on their ability to connect scientific principles to real world applications.

Note: Review the assessment items which are presented throughout the Performance Standards TAMS for ideas which can be adapted for this TAM. You should also refer to the Performance Standards Implementation Handbook for additional assessment examples and ideas.

Summary

The boundaries between science and technology are quickly becoming blurred. As students are made aware of the applications of science they will see how technology plays an important role in their lives.



Extending Mind & Muscle

Goal

The goal of this TAM is to introduce robotics technology by exposure to principles of robotics and power transmission while constructing and operating hydraulic and/or electric robots.



Mathematics



Communications



Science



Social Studies



Fine Arts



Health



Technology

Performance Standards

- Evaluate the primary end effector designs and describe the preferred application/environment of each.
- Evaluate the primary robotic configurations and describe the preferred application of each configuration.
- Describe the characteristics and discuss the advantages and disadvantages of the three basic power systems responsible for driving robotics (hydraulic, pneumatic, and electrical).
- Recognize and analyze the potential positive and negative impacts of the increased use of robotics on students, their future employment, and society.
- Practice all safety procedures when interacting with robotics and when using the tools associated with constructing robots.
- Identify the various foundation skills for different career options in robotics.
- Solve problems related to the construction of a robot.
- Communicate orally, visually, and/or in writing the principles of a hydraulically-powered robot.
- Develop a design for and solve problems related to constructing a simple robot.
- Develop a program for picking and placing an object in a simulated workplace.
- Identify typical applications in which robotics are effectively used in industry.



Introduction

Robots are no longer science fiction. They are current technology in the workplace, and their use is extending beyond the factory. They're in hospitals, specialty department stores, and space. Soon they'll probably be in your home!

The increasing use of robots in industry is the result of the need for improved productivity and worker safety. Robots can release humans from the hazards of spray painting and heavy lifting as well as from the boredom of repetitious jobs. Robots can be programmed for extreme accuracy and equipped with sensors to provide feedback on their performance. Although some workers will be displaced by robots, workers will be needed in other areas to develop, program and maintain the robots.

Robots may be powered by hydraulic, pneumatic or electrical systems. This TAM presents plans for construction of a hydraulic and an electrical powered robot. Activities are presented for programming robots constructed from inexpensive materials as well as those from purchased kits.

Objective Statement

The activities described in the following pages represent samples of activities which can be used to deliver these performance standards on page 1. Many additional activities can and should be used. Extreme care should be taken to connect each activity with appropriate activity objectives as well as with the performance standards. These objectives should be developed by the instructor and should be shared with and made clear to the students.



Integrated Activity Idea

Develop an overview of the history of robotics. Then extend your thinking to the year 2010. What impact, if any, do you think robotic technology will have on our cultural values?



Technology Idea

Plan a robot fair where the technology department demonstrates all the robots for some other groups in the school. Follow with a discussion of impacts of robots on work place. If you are in a junior high, demonstrate for the incoming fifth or sixth graders to promote interest in your program.



Technology Idea

Explore possible career options in robotics. If possible, visit an industry where robots are used and interview a manager and a technician regarding the skills and educational background necessary to perform successfully in robotics related fields.

Activity 1

The What and How of Robots

This activity will use several activities to develop students' vocabulary and understandings of robots.

What is the difference between a robot and an automated machine? What are the names given to parts of a robot? How are robots powered? How are robots used? For answers to these questions, read on.

Procedure

- Using the Usborne book "Robotics" complete the front side of the attached worksheet. (See pages 30-31).
- Using the software "Industrial Robotics" read and answer the 30 questions on the three disks. Your scores will be stored on the disks for teacher retrieval. While answering the questions on the computer complete page two of the attached worksheet.
- Bring in any robot you might have at home (or use one from your technology education lab) to demonstrate parts and actions. Radio Shack has sold a couple of different ones. There are toy locomotives that run into objects and then change direction. There are a variety of robotic kits that can be built or bought assembled.

Summary

Students should now be familiar with robotic terminology, uses and characteristics. They are ready to construct a robot.

Materials Needed

Book: Potter, Tony & Guild, Iver, 1983. *Robotics*. London: Usborne.
Software: Industrial Robotics, Shopware
Worksheet: attached



Activity 2

Make a Hydraulic Robot

This hydraulic robot is designed to be a pick and place robot. A hydraulic robot is powered by fluid under pressure. Hydraulic power is widely used for robots, especially in situations where lots of power is needed. In this case, the syringe plunger provides pressure on the water in the syringe and tubing which acts on another syringe and its plunger. This second plunger is attached to mechanical parts to activate a rotating base, shoulder, arm and wrist joints. When the syringes are first operated they may work pneumatically—meaning they will operate with only air in the cylinders. As the plungers wear a little they must be powered with fluid.

The robot is made of very light weight materials. It weighs less than one pound. However, it is unusually strong and has impressive movements. When you have finished construction of the robot you will be able to experiment with the range of motion of the four axes and program a set of commands to solve a pick and place problem.



Integrated Activity Idea

Develop a clear set of directions for operating the robot, including graphics as necessary.

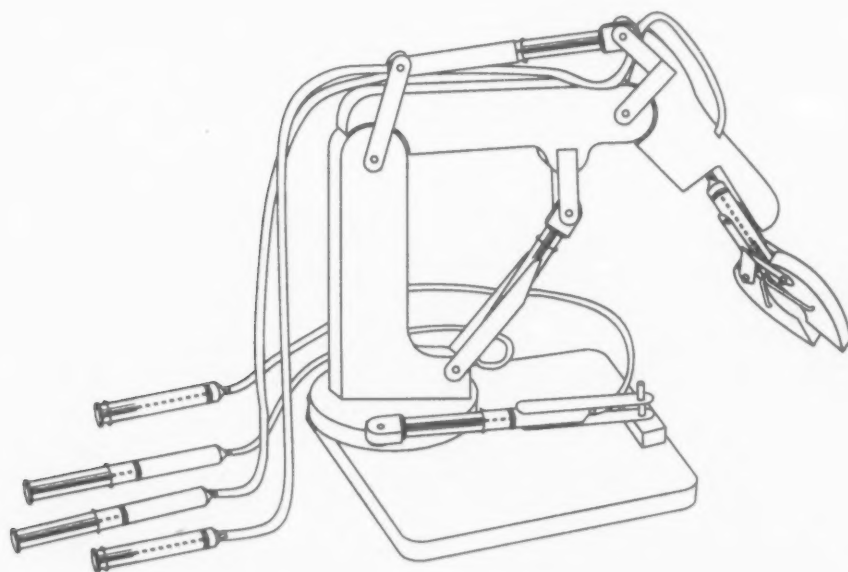


Figure 1 - Robot



Technology Idea

Demonstrate the following robotic action. Practice using this hydraulic robot to pick a 35 mm film canister from the table; raise it 5 inches; move it 12" horizontally; then place it on the table again.

Procedure

Note: Appreciative acknowledgment is given to Sam Claggett for allowing this adaptation of the robot plan he developed.

Styrofoam Parts

1. Use templates to layout the following parts:

Part No.	Qty.	Description	Approx. Size
1	1	Base	11" x 11"
2	1	Base swivel	6 1/2" diameter
3	1	Body	5" x 11"
4	1	Upper arm	3" x 12"
5	1	Forearm	4" x 9"
6	2	Gripper	2" x 5"
7	1	Base swivel pivot base	1" x 2"
8	3	Plunger attachers	1" x 1"

2. Obtain an oblong piece of 1" x 11" x 24" and a 7" square piece of high density Styrofoam.
3. Lay all patterns, except the circle, on the oblong piece of Styrofoam as shown in Figure 2. Careful planning avoids wasting materials. Lay circle pattern on 7" square. Draw around templates with a pencil or marker.



Integrated Activity Idea

Write an explanation of how a hydraulic robot works such as required for entry in Expo. (Demonstrate understanding of axes, arms, gripper, pick and place, fluid transmission of power and their interaction.)

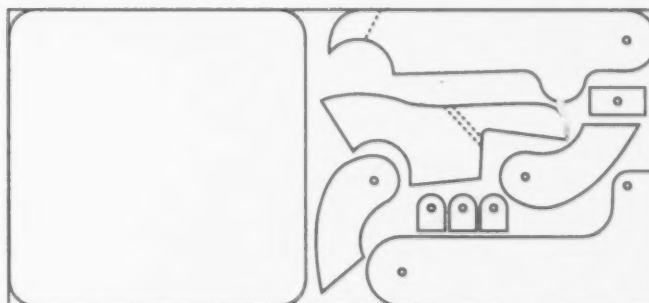


Figure 2 - Templates

4. Turn on the Styrofoam cutter. Do not touch cutting wire. The wire will get hot enough to burn you almost instantly. **Caution! Always use a piece of wood to remove pieces of Styrofoam from the hot wire. Melted Styrofoam is very hot!!** Instructor's Initials
5. Place a piece of Styrofoam on the Styrofoam cutter table and start feeding the Styrofoam into the hot wire. Push the Styrofoam into the hot wire until the wire contacts the outline. It is important to move at an even



pace - do not go too fast and bend the hot wire or too slow and burn the Styrofoam. Continue until all pieces are cut out. Styrofoam should not be allowed to stay on the wire and smoke.

6. Smooth the edges of the Styrofoam with medium grit abrasive paper. Inside curves may be sanded on a spindle sander. Other kinds of power sanders tend to melt the Styrofoam rather than smooth it.

Instructor's Initials

Wood Parts

7. Obtain 15 tongue depressors and a can with about an inch of warm water in the bottom. Place the tongue depressors in the water and allow them to soak for about five minutes on each end.
8. Place each tongue depressor in the center pusher of the classroom three hole punch. Punch holes in both ends of each tongue depressor. See Figure 3.

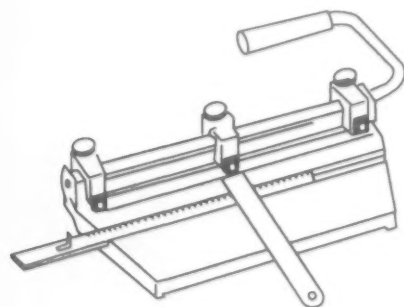


Figure 3 - Heavy Duty Hole Punch.

9. Use templates and layout the following wood parts.

Part No.	Qty.	Description	Size
9	2	Shoulder hinge	3/4 stick
10	2	Biceps cylinder attachment	Slant cut
11	8	Forearm hinge	1/2 stick
		Biceps plunger	
		Gripper	
		Upper plunger	
12	2	Upper cylinder	7/8 stick
13	4	Gripper Y support	1/2 stick slanted
14	2	Base swivel cylinder	Full length
15	1	Base swivel attachment	1/3 stick



Integrated Activity Idea

Study the chemical composition and physical properties of styrofoam. What applications are ideal for this material? What new materials have these same desirable characteristics?



Integrated Activity Idea

Study the potential health hazards of styrofoam fumes. What are the chemicals? Are they safe?

10. Using straight metal snips, cut each tongue depressor in the shape of a template. Parts #11 needs to have the tongue depressor cut only once to make two parts; therefore you can get 8 pieces out of 4 depressors. Sand off any sharp or splintery edges. Punch new holes in the end of part #9 and #12. **Instructor's Initials**
11. Obtain dowel cutting fixture and 1/4" dowel (approximately 25"). Clamp fixture in vise. Put dowel through hole in fixture as shown in Figure 4. Cut ten 2" long pieces with the hacksaw or coping saw. Sand sharp corners.



Technology Idea

One important technological process is innovation. This often takes the form of thinking of alternatives to current designs. As you do this activity be thinking of ways you could change and improve on this design or make it with another material.

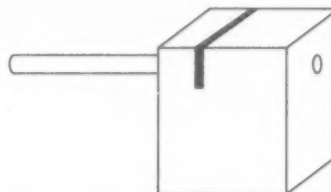


Figure 4 - Dowel Jig - Dark line is 2" from right edge.

Cardboard Pieces

12. Obtain two 7" cardboard squares and the 6 1/2" diameter template. Draw two 6 1/2" circles on the cardboard using the template. Also mark hole in the center of each circle. Using scissors, carefully cut out the two circles.
13. Obtain the grommet kit. Identify pieces as shown in Figure 5.

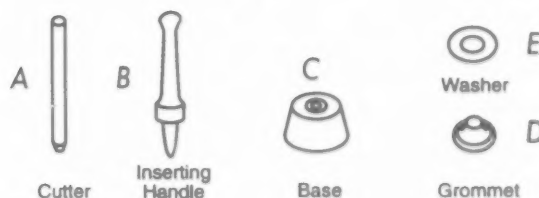
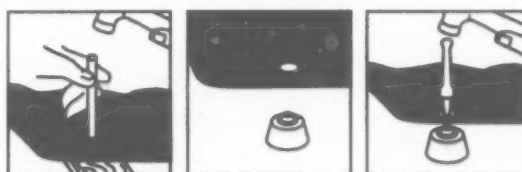


Figure 5 - Grommet Tools

Place the marked center hole of one piece of cardboard on the scrap wood block. Put the 3/8" center punch (A) over mark. Strike punch hard with rawhide mallet to cut hole. Do the same with the other circle.



Technology Idea

Designate a bulletin board for robotics. Any student who brings a clipping from a newspaper or magazine related to robotics and puts it on the bulletin board gets extra credit points.



14. Place a grommet (D), post up, on base (C). Center holes in cardboard over tube.
15. Place washer (E), rounded side up, tightly over grommet tube and circles. **Do this carefully as you get only one grommet.** Insert handle (B) into tube. Strike handle firmly with mallet until the cardboard pieces are held together but loose enough to turn easily.

Instructor's Initials

Now you should have all the parts you need for assembly.

Assembly

To operate a robot it is important all parts move correctly. Once glue is applied it is not easy to rearrange parts to improve movement. For this reason study the diagrams and make a trial fit before gluing. Assembly should be done in three subassemblies. They are arm, base, and end effector.

Arm Subassembly

16. Plug in the hot glue gun. Have gun on a piece of sheet metal to catch the melted glue. **Caution: melted glue is very hot and can burn you!**
17. Use the assembly jig to glue two #11 pieces at right angles. Let assembly cool about 2 minutes and then remove the piece. Get two more #11 pieces and repeat process. Jig is shown in Figure 6.

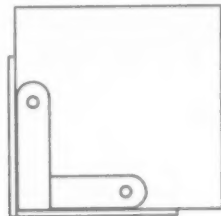


Figure 6 - Assembly jig

18. Glue one of the pieces made in step 17 to Styrofoam forearm (#5) as shown in Figure 7. For exact placement lay forearm next to outer end of upper arm. **Instructor's Initials**

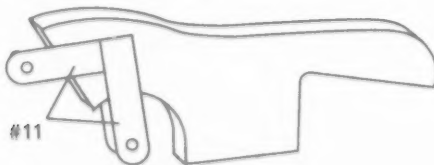
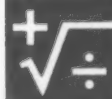


Figure 7 - Jig

19. After looking at the robot picture, place hot glue on biceps plunger attachment (#11) and fasten to the upper arm.



Integrated Activity Idea

Compute an efficiency ratio between human energy expended to operate the robot and the work exerted by the robot.



Technology Idea

Write a report explaining how this hydraulic robot works. Then this robot with its directions could be entered in the Missouri State Exposition. Use at least 8 robotic vocabulary words.



Technology Idea

Develop a comparison and cross reference chart of various types of adhesives and their applications. Desktop publish the chart complete with some graphics of sample applications. Laminate the completed worksheet for use as a reference display in your technology education labs.



Technology Idea

Have electronics students, or gifted students, assemble robotic kits (line tracer, piper mouse, walking robot) and use them to demonstrate sensors.

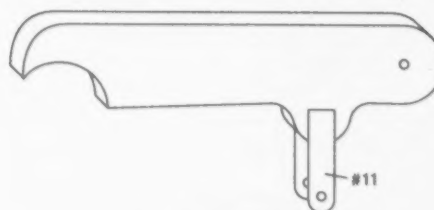


Figure 8 - Position of Bicep

20. Put a piece of 1/4" dowel rod through the hole in the end of the biceps plunger attachment then put another #11 wooden piece on the dowel to align the hinge. Glue the second wooden piece in position on the other side of the Styrofoam. Remember you do not get a second chance to change the position of the piece, so be accurate.
21. Glue shoulder hinge (#9) in position on the upper arm as done in the robot picture and shown in Figure 9. Follow the steps used in step 19.

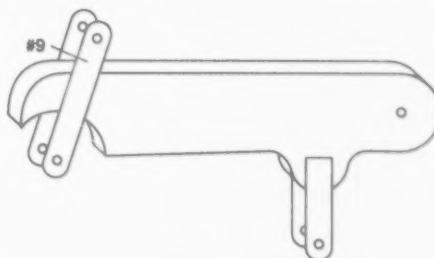


Figure 9 - Position of Shoulder Hinge

22. Now you can connect the forearm and upper arm to make an elbow joint by using the 2" dowel rods. To do this, carefully align the arms leaving about 1/4" space between pieces. Then take a sharpened dowel rod to stab a hole in the Styrofoam to connect the arms. Insert 2" dowel through wood and Styrofoam. **Instructor's Initials**

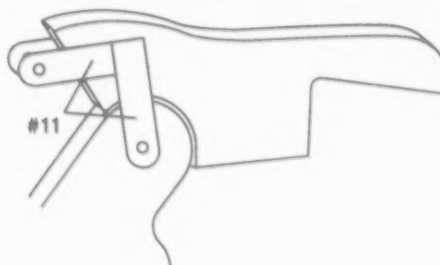


Figure 10 - Elbow Joint



23. Glue the biceps cylinder attachment (#10) to a large syringe. It is very important to get the correct angle of alignment, so look carefully at the picture. Place glue on side of syringe, and then press wood piece into the heated glue until it cools. Align another #10 piece on opposite side of syringe and glue. Glue Styrofoam plunger attachment (#8) to the end of the syringe plunger. **Instructor's Initials**



Figure 11 - Biceps Cylinder

24. Attach the upper cylinder attachments (#12) to a small syringe. Glue Styrofoam plunger attachment (#8) to the end of the syringe plunger.
25. Stab hole in center of plunger attachments, then attach to hinge on forearm with dowels. Connect other end of upper cylinder attachment to shoulder hinge on upper arm with dowel.

Base Subassembly

26. Place the cardboard base swivel hinge on the base (#1) in a position similar to the sample. Draw a circle where the center of the swivel will be located. Press the Styrofoam down in the area under the grommet so that the cardboard circle will lay flat. Do the same on the base swivel (#2).
27. Using the hot glue gun attach one side of the cardboard swivel hinge to the base and attach the base swivel (#2) to the top side of the swivel hinge.
28. Hot glue base swivel attachment (#15) to base swivel. Make sure the end with the hole is sticking out.

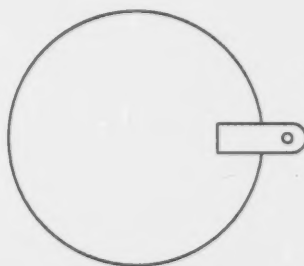


Figure 12 - Position of Base Parts

29. Align the holes in the base swivel cylinder attachments (#14) then glue to a large syringe. Glue a plunger attachment (#8) to end of the syringe plunger. Use the same method as on the upper cylinder.
30. Using a sharpened dowel locate the large syringe on the base swivel pivot base (#7). Now attach the syringe with a dowel. Also, stab a hole in the plunger attachment and attach to depressor using 2" dowel.



Integrated Activity Idea

Prepare a report on the future of robots. Use the information to develop a storyboard for a video. Then make the video. (See TAM 7 by Dave Boyt for video making information.)



Technology Idea

Take a field trip to a company that uses robots. If you cannot take a field trip, see if they will allow you visit and take pictures with a camcorder for use in class or if they have a video they would share.

Gripper Subassembly



Technology Idea

Design and construct an end effector for a robot. You may wish to begin by looking at toy robots, pictures of industrial robots, etc., for ideas. Then be creative. End effector design is the most interesting, challenging and creative part of robot design!

31. Place Y support (#11) and two gripper attachments (#13) in position on the assembly jig. See Figure 13. Glue in place. Let glue cool, then remove piece and assemble another Y support.

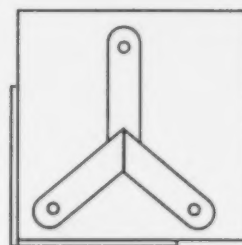


Figure 13 - Position of Gripper Support

32. Carefully line up both pieces made in step 31 on opposite sides of a small syringe so they are even and the holes line up. Place a line of glue on the syringe along the side that does not have finger grips. Now attach the Y assembly to the syringe. After the first side is in place repeat the process on the other side. **Instructor's Initials**

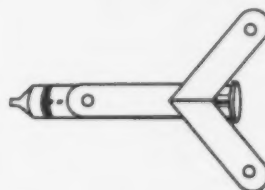


Figure 14 - Position of Gripper Syringe

33. Place the gripper jaws (#6) in the Y assembly and stab a hole through the gripper jaws. Now attach the gripper jaws using dowel pegs. See Figure 15.

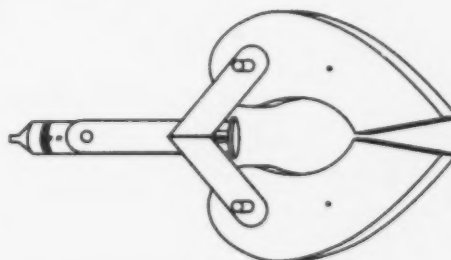
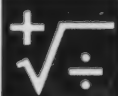


Figure 15 - Position of Gripper Jaws



Integrated Activity Idea

Develop program for doing a specific pick and place operation gauging moves by changes in amount of cc of fluid in syringes. Place visual barrier between gripper and object and controller; then have controller do the operation from written program. Degree of accuracy determines grade.



34. Remove the plunger from the syringe and punch four small holes in its handle with an awl. Use awl carefully. See Figure 16.



Figure 16 - Placement of Holes

35. With fine wire attach two pieces of clear plastic tubing, each 1' long, to the plunger handle. See Figure 17. **Instructor's Initials**

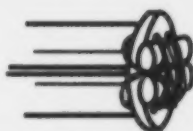


Figure 17 - Attachment of Tubing

36. Cut two pieces of heavy wire 7 1/2' long using side cutters. Using pliers bend the wire around the fixture provided for this purpose until the wire is shaped as in Figure 18.

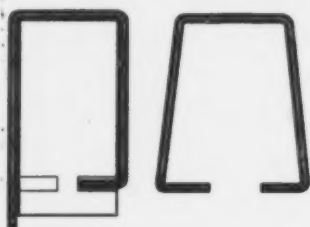


Figure 18 - Forming Wire

37. Take the gripper rods you made in step 36 and run them through the tubing attached to the end of the plunger. Put plunger back inside syringe. Position gripper jaws tightly together and the plunger all the way in. Keeping jaws straight stab the wire ends into the gripper jaws as shown in Figure 19.

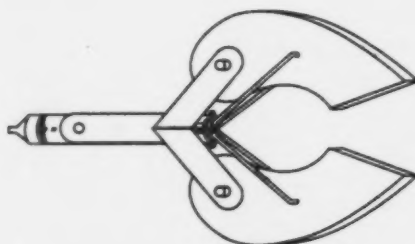
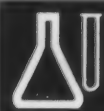


Figure 19 - Attachment of Wire



Integrated Activity Idea

Contrast the properties of hydraulic and pneumatic systems. Now do air and fluid behave differently in enclosed systems? When under pressure?



Technology Idea

If you have time, you may want to design a holder for the control syringes to make them easier to operate. Putting a drop of food coloring in each control syringe helps distinguish which syringe operates which axis.



Integrated Activity Idea

Dress the robot up using color or other design features to enhance its appearance.

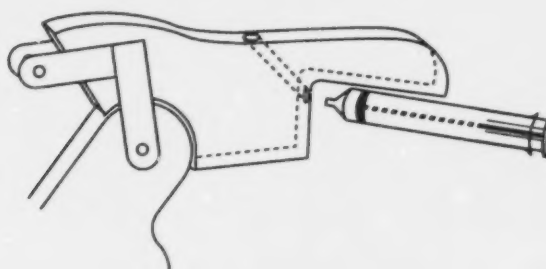


Figure 20 - Placement of Tubing

38. Using a sharpened dowel make a hole in the forearm (#5) for the tubing that operates the gripper to go through. Do not go through the narrow part of the arm because that will reduce its strength. (Figure 20)

Cut a 3 foot piece of clear tubing and put it through this hole. Now attach it to the syringe in the Y assembly.

39. Glue the Y assembly to the forearm.
40. Glue the bottom of the body to the swivel base. Hold parts in position until glue is thoroughly cooled. You may want to add two triangle supports to strengthen the body piece.

Powering the Robot

41. Obtain two small and two large syringes from the teacher. Cut two pieces of tubing 1 foot long and one piece 2 feet long. Attach these to the syringes. Place the end of the tubing in a can of water. Draw the water into the syringe until it is full. Hold the tube high in the air so any trapped air will go to the top of the syringe. Now force it out by pushing on the syringe plunger. After any trapped air is removed attach the tubing to the matching syringe located on the robotic arm. You may discover other ways of eliminating the air bubbles.

Congratulations! You are now ready to start operating your pick and place robot.

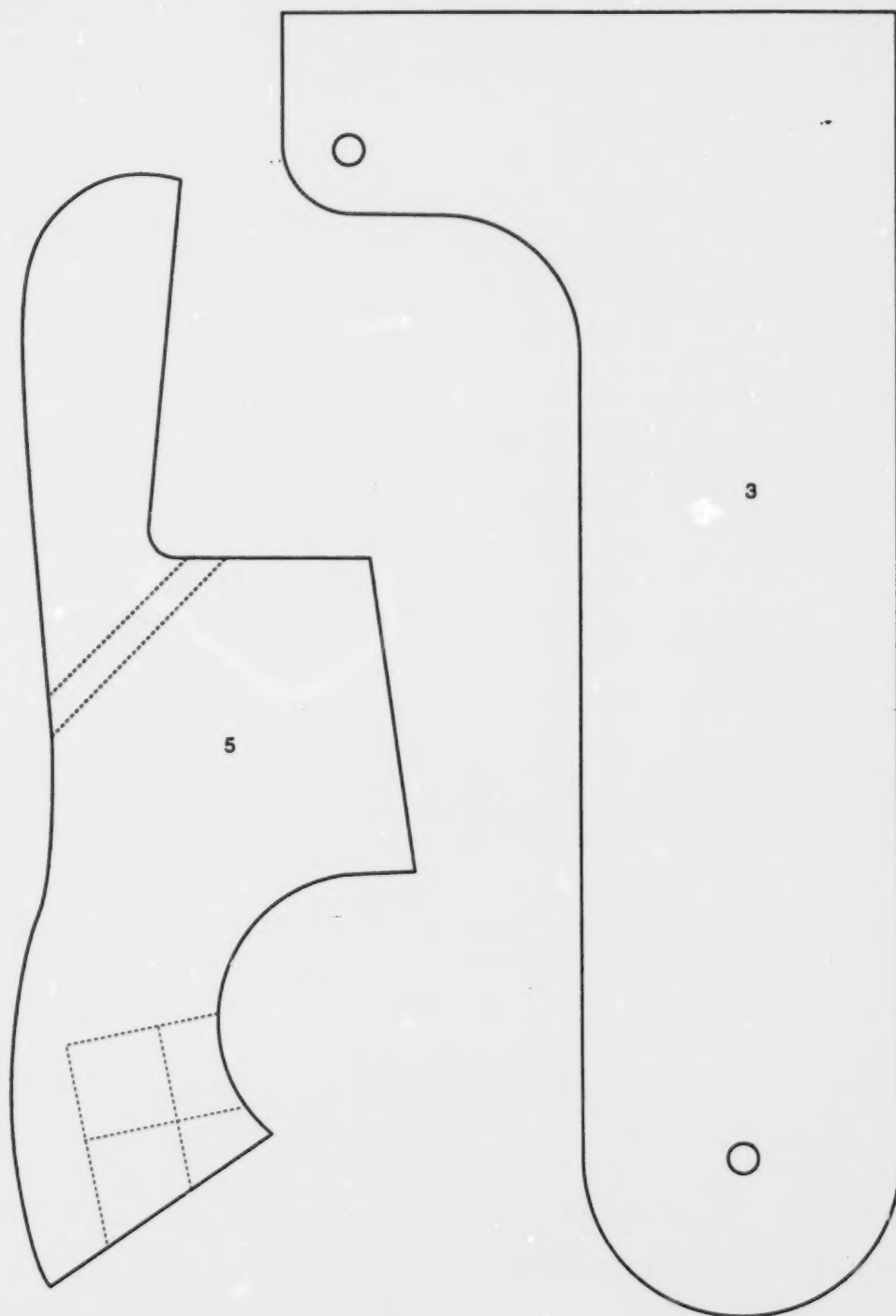


Integrated Activity Idea

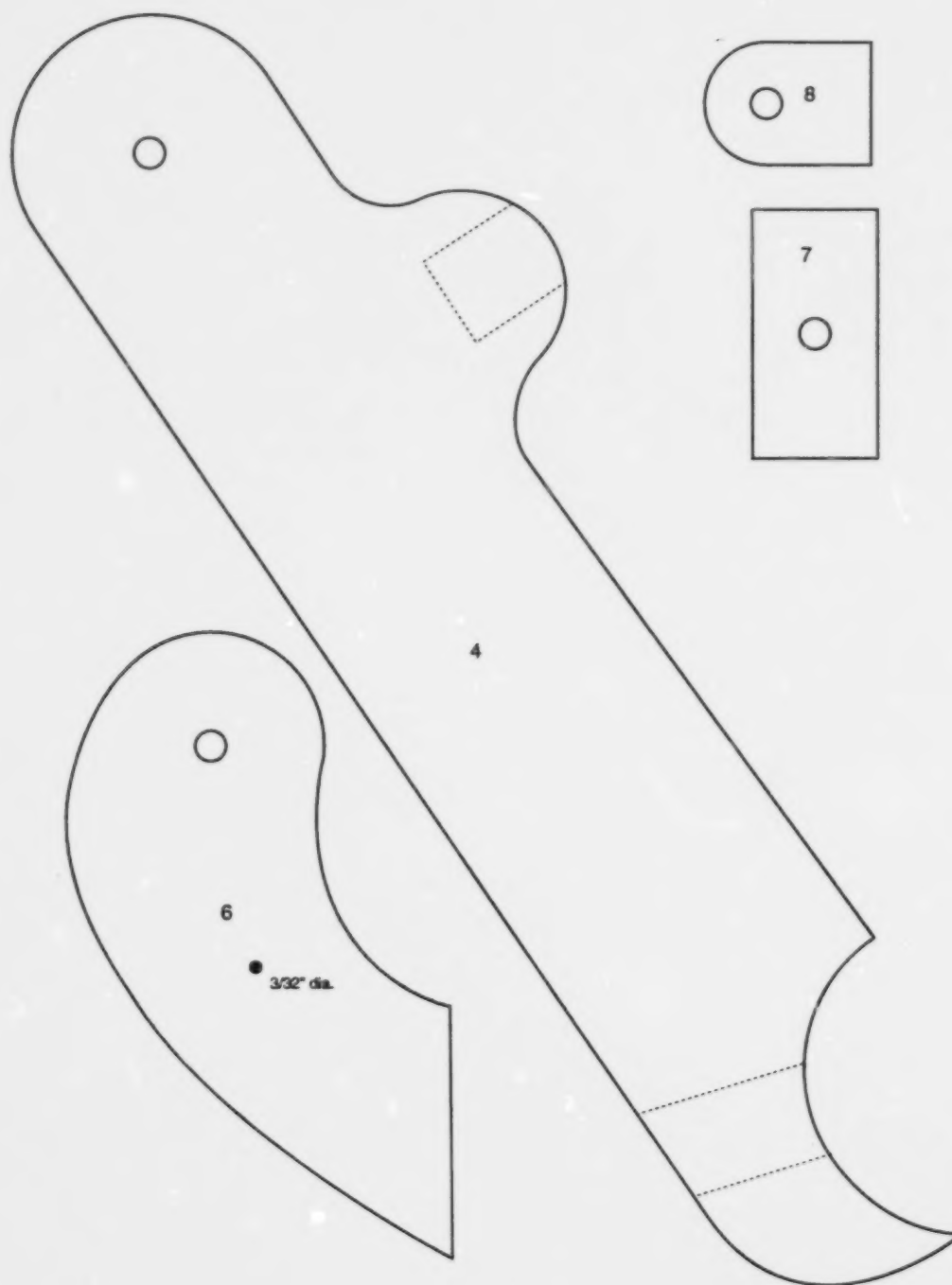
Make a video which synchronizes robotic movement of your homemade robot with music. Try to arouse an emotion such as humor, sentiment, etc.

Programming Idea

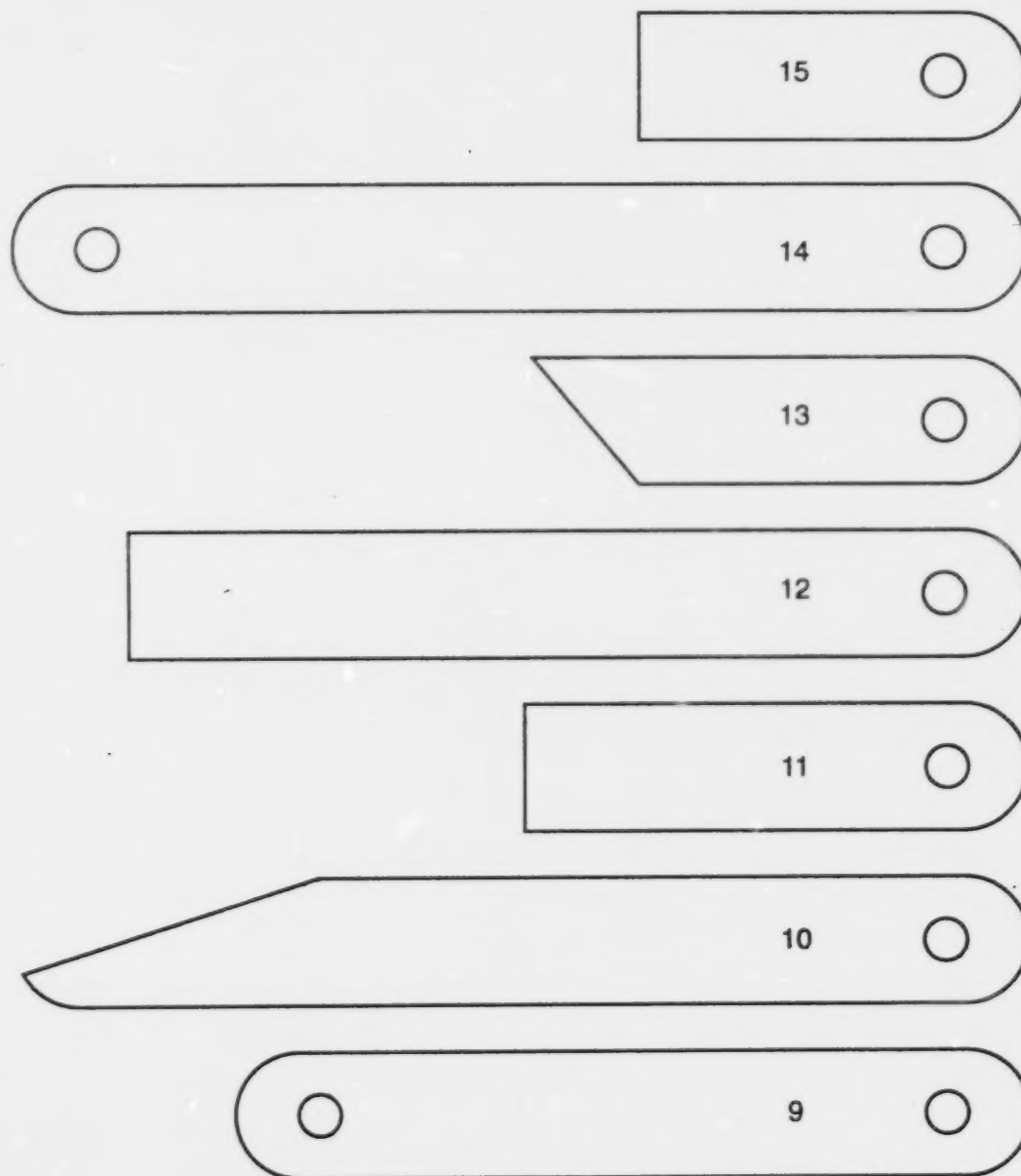
Place a film canister on the table in front of the robot and mark the spot with tape. Look at the number of cc of water in the controlling syringes and record the amounts on a chart. As you move a syringe plunger to pick a 35 mm film canister from the table, raise it 5 inches, move it 12 inches horizontally, then place it on the table again, record on the chart each change in volume of water in the syringe. Mark the target spot for the canister. This is called programming. When you have an accurate program recorded ask for an evaluation. A piece of cardboard will be placed so you cannot see the canister or the gripper. Follow the program and see how exact you are in placing the canister in the target area.



The template shown is 75% of its original size. You will need to enlarge it to 125% on your copy machine.



The template shown is 75% of its original size. You will need to enlarge it to 125% on your copy machine.



The above template is at its original size. You do not need to enlarge it.

Materials Needed

Materials

Four 30-35 cc syringes without needle

Four 20 cc syringes without needle. Available from T-Plex Industries, Inc., 255 Wolfner Drive, St. Louis, MO 63026. (1-800-727-0481)

Seven feet 1/4" plastic hose. Available from aquarium supply or farm supply stores

1 pc 11" x 24" high density Dow Styrofoam (must be 1" thick)

1 pc 7" x 7" high density Dow Styrofoam (must be 1" thick)

2 pc 7" x 7" heavy poster board

One 3/8" grommet

3 hot glue sticks

7 1/2" #16 steel wire

15 Tongue depressors 7/8" x 6"

36 inches 1/4" dia. dowel rod

Equipment

Hot wire cutter

Grommet set

Hot glue gun

Heavy duty 3 hole punch

Templates for parts

Straight metal snips

Pliers

Rawhide mallet

Scissors

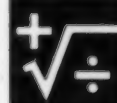


Activity 3

Electrically Powered Mobile Robot

Introduction

Robotics may be powered by hydraulic, pneumatics, or electrical motors or a combination of these systems. There are two main types of robots, mobile and arm. This project is an electrically powered mobile and arm robot. It has only two axes but the mobile base increases its capabilities. The motors run approximately 2000 RPM. The revolutions per minute are reduced to something usable in this project by using pulleys and a potentiometer to reduce the voltage. Have fun constructing and operating this robot!



Integrated Activity Idea

Program a robot using computer program.

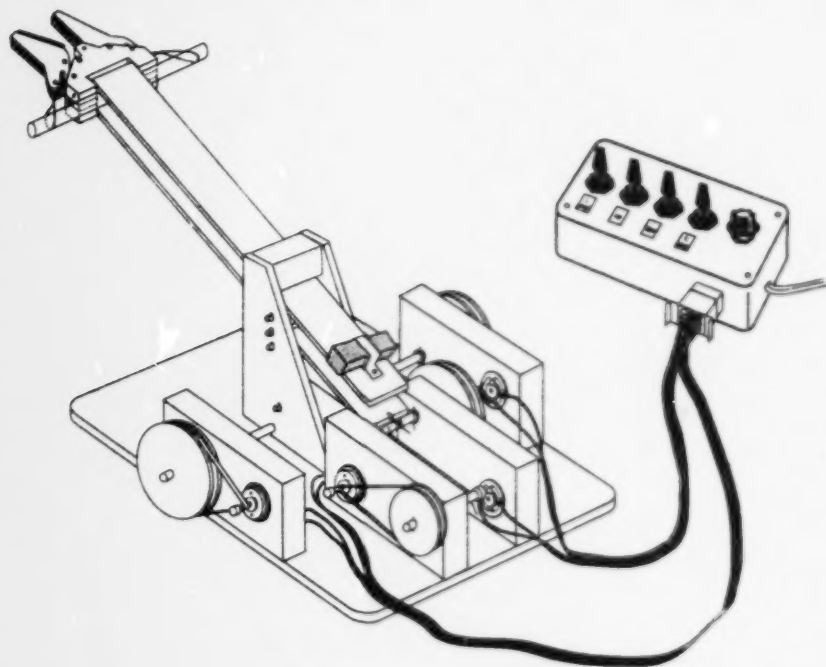


Figure 21 - Robot and Power Pack



Integrated Activity Idea

Demonstrate robot to a social studies class and give oral explanation of axes, arms, gripper, pick and place, fluid transmission of power and their interaction. Present information on impacts on the work force of this technology. (Organize, outline and orally present ideas.)

Procedure



Integrated Activity Idea

Write a technical report explaining your solution to two problems encountered during construction using at least five words related to robotic technology. Report should include statement of two problems, two solutions, five robotic technology words, and a paragraph on the strengths and weaknesses of electrical powered robots. (Information on this is available in the resource books.)

Gripper Assembly

1. Stack four pieces, 2" x 6," of 1/8" thick hardboard together and temporarily nail them with a 4D nail in a stack. Cut out templates A and B and glue to top of stack with rubber cement. Drill holes as marked, be very accurate. Saw pieces to shape with scroll saw, coping saw or band saw. Sand to outline if necessary.
2. Glue the pieces together with white glue as shown in Fig. 22. Keep holes in line with nails. Clamp with snapper clothes pins. When glue is dry sand edges following template outline.



Figure 22 - Gripper Jaw

3. Stack two pieces of 1/2" x 2" x 3" pine on top of each other and temporarily nail them together. Cut out template C and glue to top piece with rubber cement. Drill holes as marked. BE VERY ACCURATE! Saw pieces to shape and sand to outline. **Instructor's Initials**
4. Draw outline for template D on 1/4" plywood, saw and hand sand to proper dimensions.
5. Assemble the two parts C and D like a sandwich as shown in Fig. 23. Place 4D common bright nails through the drilled holes to line them up before gluing and clamping. When dry, sand edges even. Place finished part in drill press vise being careful to square it vertically. Drill 1/8" holes as shown for wrist pivot pins.

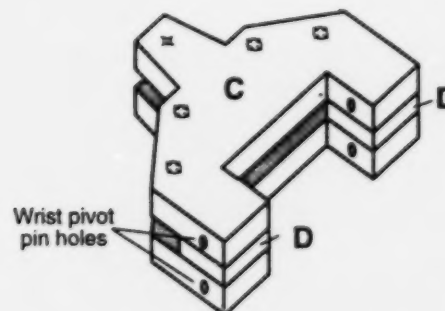


Figure 23 - Gripper Wrist



6. Rubber cement template E to a piece of $\frac{1}{4}$ " x $\frac{3}{8}$ " x 6" plywood (5 layer birch is great). Drill holes accurately with $\frac{1}{8}$ " bit. Saw and sand the four pieces to outlines. **Instructor's Initials**
7. Cut four 4d common nails to $\frac{1}{2}$ " length. Assemble gripper as shown in Figure 23. Use shortened nails to hold jaws to part E. Use full length 4d nails, with ends filed square, to attach other end of struts to part C/D. Put a little hot glue on bottom end of nails to hold them in place. Place cutoff 3D nails in small holes as shown.
8. Thread fishline through small holes in part E around center nail and back to arm as shown in Figure 24.

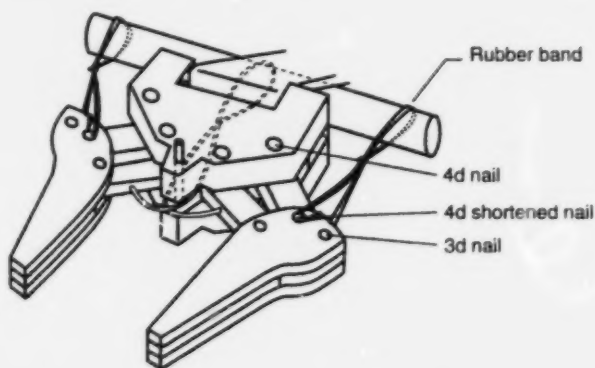


Figure 24 - Gripper Assembly

9. Glue foam rubber to inside of grippers for better grip on objects.

Arm Assembly

10. Cut two pieces of plywood $\frac{1}{4}$ " x $1\frac{1}{2}$ " x 12." Drill $\frac{3}{8}$ " holes in one piece to make slot as shown in Figure 25. File slot smooth. Sand all edges.

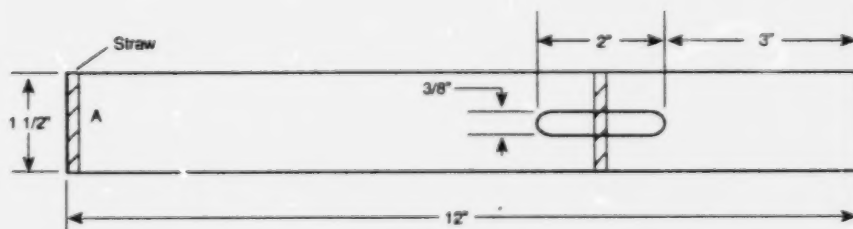


Figure 25 - Arms

11. Hot glue $1\frac{1}{2}$ " lengths of straws to arms in position indicated.
12. Cut two $2\frac{1}{2}$ " lengths of $\frac{1}{8}$ inch rod to go through back of gripper and straws (A) at end of arm to make wrist joint.



Technology Idea

Conduct a robot competition in the lunch room, or at some other appropriate time and place, where students operate the robots they have made in an egg dipping contest using rules from the State Expo competition.



Integrated Activity Idea

Figure ratio accomplished in gearing down with use of pulleys.



Integrated Activity Idea

Design, build and paint a carrying or storage case for the robot to individualize it.

13. Place a 5" piece of 1/4" dowel behind gripper and between arms. Attach rubber bands between end of dowel and nails on gripper. You may need to tie a knot in the rubber band to get the correct tension. (See Figure 24.)

Base

14. Cut and sand 8 1/2" x 11" piece of 3/8" plywood for base.
15. Make two pieces of template F from 1/4" hardboard or plywood. Drill holes as marked.
16. Cut a piece of wood 1/2" x 1 5/8" x 3." Cut another piece 1/2" x 5/8" x 1." Glue and nail these pieces between the parts made in step 15 to make a shoulder for the robotic arm. Attach with screws to base at spot shown on base template. Attach a roller on bumper on the under side of the base in the center front and center back to keep base balanced.

Motor Mounting and Gearing

17. Make four pieces of template G from 3/4" thick softwood. Check the size of the motors you are using, then drill hole for mounting in blocks. Motors may be wound with tape for tighter fit in hole. Holes for pulleys may be drilled 1/4" in diameter but the use of a bearing made of plastic or metal will allow for freer movement of the axles. If you use a bearing, drill appropriate size hole.
18. Attach mounting blocks on base as shown. Put only one screw in each piece now to allow adjustments when adding motors and pulleys.
19. Using fly cutter or hole saw, cut from 1/8" hardboard six circles approximately 3" in diameter, three circles with 1/8" smaller diameter, one circle 2" in diameter, and one circle 1 7/8" in diameter. Make fixture shown in Figure 26 and clamp to disc sander table. Place circles on peg and then use pivot arm to control circle and sand round.

Instructor's Initials

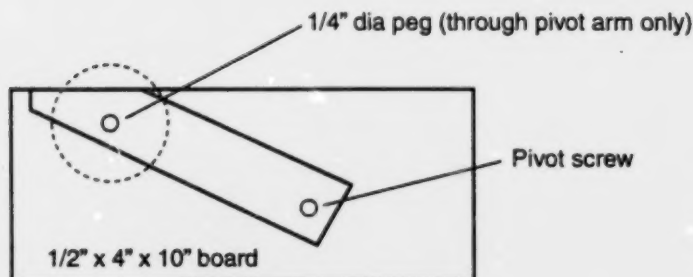


Figure 26 - Sanding Fixture

20. Cut four 3" pieces of 1/4" hardwood dowel. Using fixture shown in Figure 27 glue two 3" circles on either side of 2 7/8" circle and glue unit to end of dowel. Clamp in position. When dry repeat process to make three more pulleys.

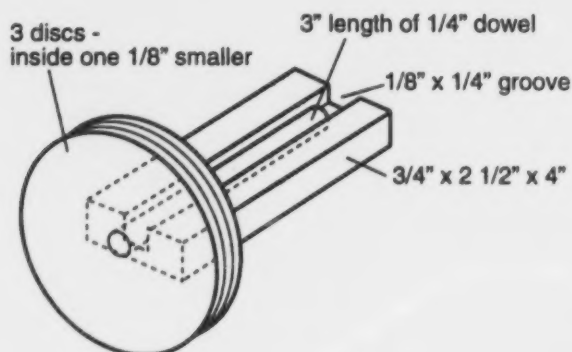
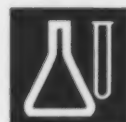


Figure 27 - Fixture for Attaching Circles to Axles.

21. Place motors and pulleys in position as shown on base template F. Drill small hole, using a cutoff wire nail as a bit, in axles of pulleys used for control of arm and gripper for attaching fishline.

Assembly

22. Assemble arm and base by inserting rods or nails through straws E and F on arm and holes in shoulder. Insert 6d nails in other holes in shoulder. Attach fishline to gripper jaw line, thread over nail in shoulder, through slot in bottom arm, under other nail, and then tie to axle using the small hole. Inserting a small spring in line will protect the line from breaking.
23. To counterbalance the arm place a $3/4" \times 3/4" \times 2 1/2"$ piece of metal bar stock, or equivalent, on arm and attach in appropriate place to balance arm. Drill a small hole in near end of bottom arm piece and attach fishline from that hole to axle of other arm motor. Place appropriate size rubber bands around pulleys and motor shafts.
24. Wire motors and connect to a 3-4 volt DC power source. DPDT switches provide for forward and backward rotation of motors.



Integrated Activity Idea

Figure voltage change with potentiometer and how to wire it in circuit.

Power Source

A train transformer can be used as the power source if it has low enough output.

A power pack can be constructed with the following Radio Shack parts:

1		Plastic box
4	275-709	Momentary center-off auto flip switch DPDT switches
1	271-265	Wirewound potentiometer 25 ohms - 2 watts
1	274-239	9-conductor female molded nylon connector
1	274-237	9-conductor male molded nylon connector
1	273-1435	AC-to-DC Adapter output 3-4 VDC

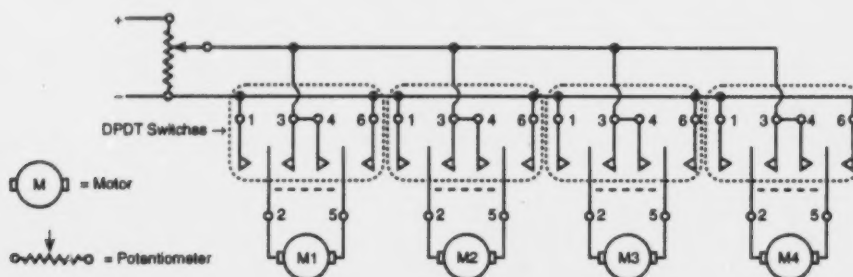
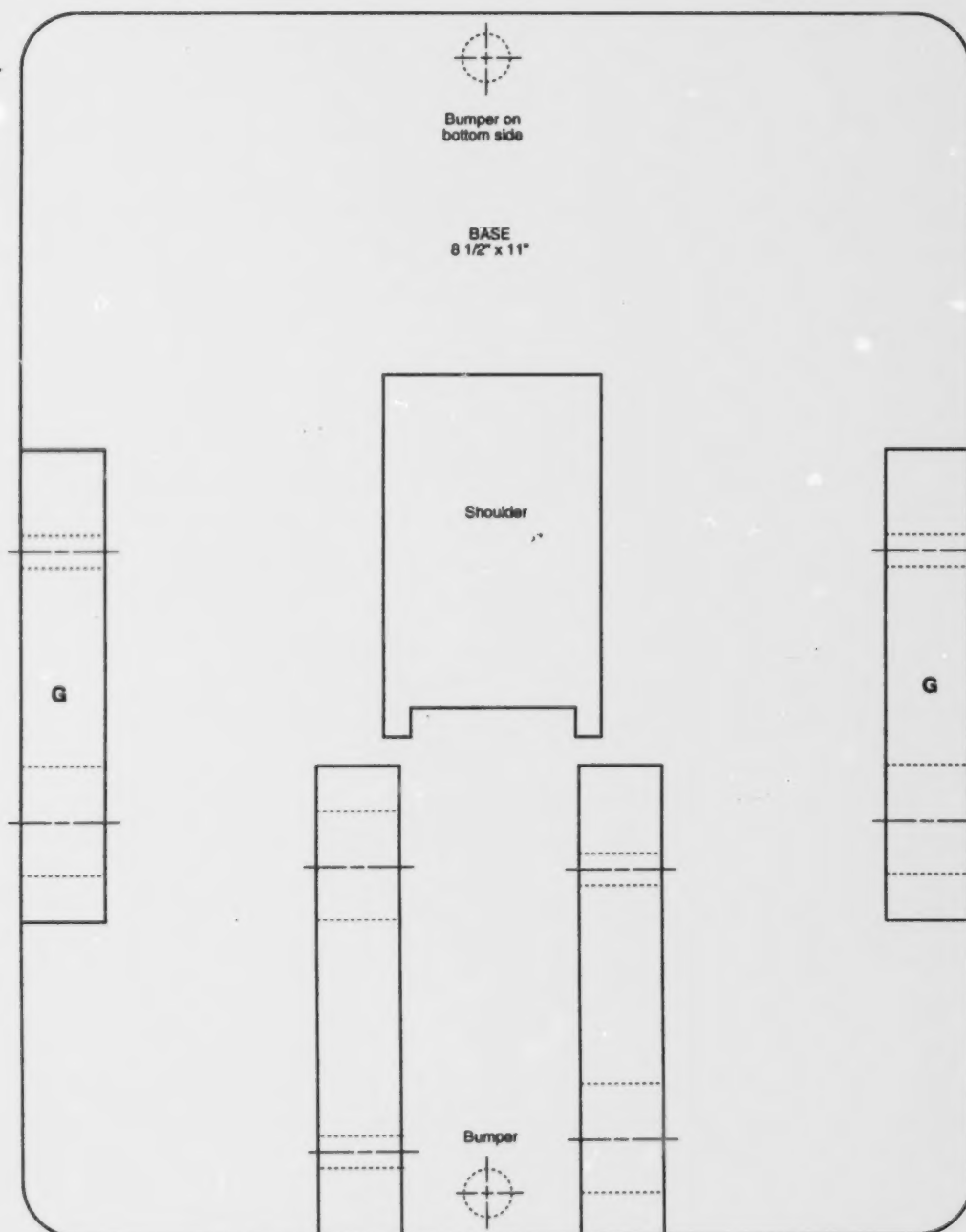


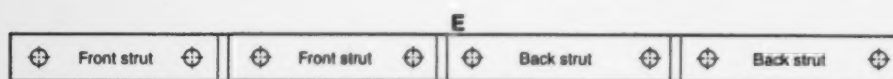
Figure 28 - Power Pack Schematic

Summary

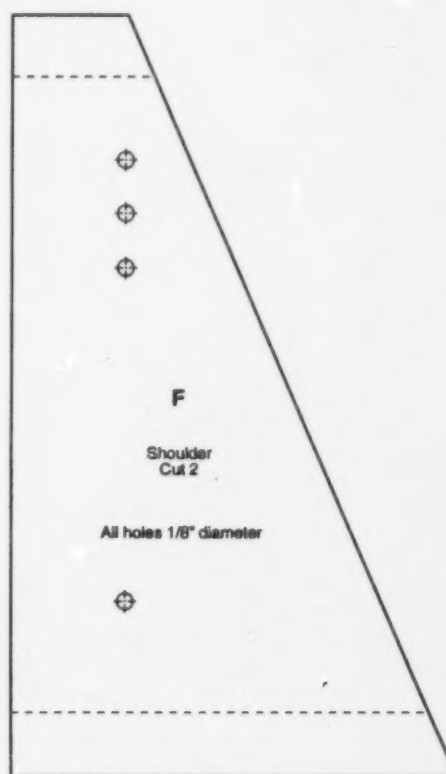
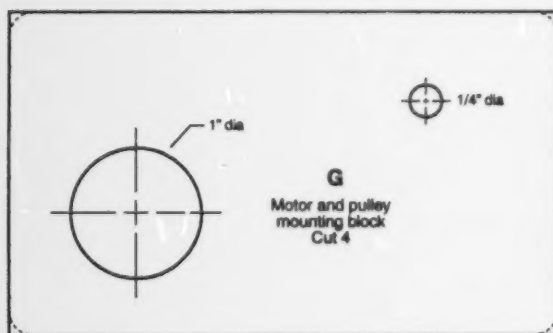
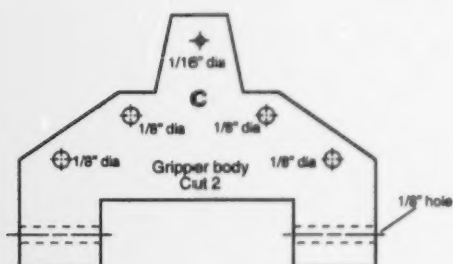
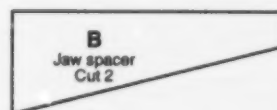
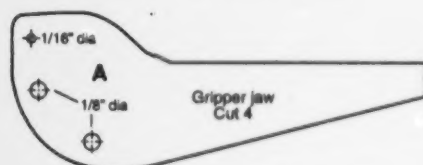
The student who has constructed this robot has learned to solve problems related to construction and engineering of a mechanical project. Energy and power principles are demonstrated with leverage, gearing down, and use of electric motors. There are several electrical related activities that can be added. For example, adding a touch sensor to tell when gripper is closed, add a signal light to signal when robot is on or backing up, adding an optical sensor to guide the robot on a course. The motors could even be controlled by a computer program!



The template shown is 75% of its original size. You will need to enlarge it to 125% on your copy machine.



Drill all holes 1/8" dia



The template shown is 75% of its original size. You will need to enlarge it to 125% on your copy machine.



Materials Needed

Supplies

- 4 DC motor with Gear 1.5 to 4.5 volts (Radio Shack 273-237)
- 24" 1/4" hardwood dowel rod
- 1 pc 1/8" hardboard
- 1 pc 1/4" plywood (5 layer birch is desirable) 4" x 12"
- 1 pc 3/8" plywood 8 1/2" x 11"
- 1 pc 1/2" pine 3" x 8"
- 1 pc 3/4" wood 2 1/2" x 18"
- 12 Nails 4d bright common
- 6 Nails 6d bright common
- 3 Nails 3D box
- 6 Wire nails 1"
- 8 Screws 1"
- 2 Screws 3/4"
- 12" 1/8" dia. metal rod
- 7" 1/8" dia. wooden or plastic rod
- 2 Plastic straws 1/8" inside diameter
- Glue and hot glue sticks
- Rubber bands
- 2 strand flexible wire or 4 strand ribbon cable
- 4 Bearings (plastic or metal) with 1/4" inside diameter (nylon spacers)
Optional, but desirable.
- 2 Bumpers or rollers for underneath front and back of base
- 4' Monofilament line (heavy)

Tools

- Fly cutter or variety of hole saws.
- Wire strippers
- Soldering gun, solder, flux
- Drill bits and drill press.

Activity 4

Programming-Telling the Robot What To Do



Technology Idea

Program a robot using a language such as basic. How does this compare with robot programming languages such as AML?

Introduction

A robot is defined by the Robot Institute of America as a multifunctional and reprogrammable device that moves something. This activity demonstrates computer controlled devices that can be programmed (given a set of instructions) and reprogrammed, to do a variety of functions. When sensors are installed on a robot they can send messages back to the computer which is another way to cause a change in the instructions to the robot.

In this activity the projects are built using LEGO® components, connected to a computer interface and programmed using the Logo language. The emphasis is on the programming not the building of the project. Other building systems may be used to give the same experiences. A computer controlled arm robot can also give students experience in the exact science of programming.



Technology Idea

Develop a report discussing the difference between lead through programming and coordinate point programming of robots. What are the main advantages and applications of lead through programming?

Procedure

1. Using the directions furnished with the building set, construct a motorized project or a set of traffic lights that may be controlled by a computer program. Test project with battery pack to see that it operates correctly.
2. Study the directions for programming, then write a program to solve a problem designed by the teacher. Enter program in computer. Test it and adjust as necessary.
3. Demonstrate and explain solution for the teacher.
4. Add a touch or optical sensor to the robot which would then send a message to the computer. Program the directions for the robot in response to the sensor's message. For example, put the robot in a box, have it stop and change direction when it hits a wall. Program it to get out the open side or gate.
5. Design a system which uses two machines to accomplish a task. For example, a conveyor belt and a robotic arm such as you might see in a factory.



Advanced Activities

- Program a vehicle and a traffic light so that the vehicle will go when the light is green.
- Design a device to be an alarm for your room if the door opens, or to serve food to guests on the patio, or to open and close a door.
- Construct a labor saving device and program it.
- Make a turtle that will hold a marker, then program it to write with the marker.
- Bring in examples of sensor-controlled devices and analyze operation, i.e., motion detector.

Materials Needed

Equipment

Motorized Lego kit with computer interface, directions, activity cards and software. (#9400)

LEGO Logo, 555 Taylor, P.O. Box 1600, Enfield CT 06083-1600, 1-800-527-8339

Battery pack and batteries

Computer system

Attached worksheet is an example of directing the student to explore a variety of programming commands.

Assessment

Scoring Rubric For Activity 3 - Electrically Powered Mobile Robot

Outcome	Wgt %	Exemplary 2 pts.	Acceptable 1 pt.	Not Yet Acceptable 0 pts.	Sub total
I. Creative Thinker					
Evaluate the primary and effector designs and describe the preferred application/ environment of each	x.5	Student correctly evaluates and describes the end effector design of the mobile and arm robot.	Student correctly evaluates and describes the end effector design with teacher's assistance.	Student does not correctly evaluate and describe the end effector design.	2 x .5 = 1
Evaluate the primary robotic configurations and describe the preferred application of each configuration.	x.5	Student correctly describes 3 preferred applications of the mobile and arm robot.	Student correctly describes 1 preferred applications of the mobile and arm robot.	Student does not describe any correct preferred applications of the mobile and arm robot.	2 x .5 = 1
II. Critical Thinker					
Describe the characteristics and discuss the advantages and disadvantages of the three basic power systems responsible for driving robotics (hydraulic, pneumatic, and electrical).	x.5	Student lists and describes 3 each advantages/disadvantages electrical robots have over other robotic systems.	Student lists and describes 1 each advantage/disadvantage electrical robots have over other robotic systems.	Student does not list and describe any advantages/ disadvantages of electrical robotic systems.	2 x .5 = 1
Recognize and analyze the potential positive and negative impacts of the increased use of robotics on students, their future employment, and society.	x.5	Student writes a technical paper on impacts of increased robotic use with no errors.	Student writes a technical paper on impacts of increased robotic use with 3 or fewer errors.	Student writes a technical paper on impacts of increased robotic use with more than three errors.	2 x .5 = 1
III. Contributing Citizen					
Practice all safety procedures when interacting with robotics and when using the tools associated with constructing robotics.	x2	Student practices all safety procedures at all times.	Student practices all safety procedures with direct supervision of teacher.	Student does not practice all safety procedures regardless of supervision level.	2 x 2 = 4
IV. Self-Directed Learner					
Identify the various foundation skills for different career options in robotics.	x.5	Student correctly completes a technical memo that identifies 5 foundation skills for career options in robotics.	Student correctly completes a technical memo that identifies 3 foundation skills for career options in robotics.	Student does not complete technical memo or has less than three foundation skills identified.	2 x .5 = 1
V. Problem Solver					
Solve problems related to the construction of a robot.	x1	Student solves own problems with limited assistance from teacher (3 or less situations)	Student solves own problems with average assistance from teacher (> 4 situations).	Student does not solve own problems or requires excessive teacher assistance.	2 x 1 = 2
VI. Effective Communicator					
Communicate orally, visually, and/or in writing the principles of a hydraulically-powered robot.	x1	Student correctly diagrams (in a mock presentation) the principles of an electric robot w/ no errors.	Student diagrams (in a mock presentation) the principles of an electric robot w/ 3 or less errors.	Student diagrams (in a mock presentation) the principles of an electric robot with >3 errors.	2 x 1 = 2
VII. Quality Producer					
Develop a design for and solve problems related to constructing a simple robot.	x2	Student designs, problem solves, and constructs mobile robot within 90% of criterion met.	Student designs, problem solves, and constructs mobile robot within 70% of criterion met.	Student designs, problem solves, and constructs mobile robot with less than 70% of criterion met.	2 x 2 = 4
Develop a program for picking and placing an object in a simulated workplace.	x1	Student designs a program that correctly picks/places 5 different objects.	Student designs a program that correctly picks/places 3 different objects.	Student designs a program that picks/places <3 different objects.	2 x 1 = 2
VIII. Technical Foundations					
Identify typical applications in which robotics are effectively used in industry.	x.5	Student correctly identifies 3 typical applications on a written exam.	Student correctly identifies one typical application on a written exam.	Student does not correctly identify any applications on a written exam.	2 x .5 = 1

TOTAL: 20 out of 20 Possible



Name _____ No. _____

Exploring Robotics Worksheet - For Use With Activity 1

Most of the answers for questions 1-9 will come from the computer instruction program, "Industrial Robots." You may use any of the books in the lab to complete your answers.

1. What is the R.I.A. definition of a robot? _____

2. What is an axis on a robot? _____

3. What is a robot's "working envelope"? _____

4. What does a pick and place robot do? _____

5. What is the meaning of CAD? _____

6. What is the meaning of CAM? _____

7. What are five tasks that industrial robots are capable of doing?

8. What kind of jobs can industrial robots do that are dangerous for humans to do? _____

9. What is the name of the new application for industrial robots where one robot serves many work stations?

Obtain the book, "ROBOTICS, What robots can do and how they work" to help you answer the following questions.

10. List two interesting facts about robots you learned on pages 3-7.

11. Most arm robots have what three main parts? (page 8)

12. What are the three methods of driving a robot? (page 24) _____

13. What is the difference between hydraulic and pneumatic systems? _____

14. What is an advantage of a hydraulic system over an electrical one? _____

15. What is another name for an end effector? (page 26) _____

16. List three kinds of grippers shown on pages 26 & 27. _____

The field of robotics is essential in education because of the needs of the future job market and the demand for robotic related skills. As with computers, the skills required can be divided into four major categories.

Match the skills with the area.

- | | |
|------------------------|---|
| 17. Users | Repair and maintain the robots and controls. |
| 18. Technicians | Change the original assignments of the robots and reprogram the robots. |
| 19. Programmers | Operate the robot arm from existing programs. |
| 20. Engineers | Design the robots and/or add computer interfaces. |



Name _____ No. _____

Computer Controlled Robot Worksheet

LEGO® CAR

*Get Activity Card #3 for the car. Pick out the parts as shown in step 1, then assemble those parts. Do the same for step 2, continue until car is complete.

*Turn to page 8 in booklet "Getting Started", follow directions and answer questions below.

1. What piece of equipment must you have to program your LEGO projects?

2. What device sends messages back to the computer?

Write a program for the following messages as shown on pages 13-14.

MESSAGE	COMMAND
3. Talk to port A	_____
4. Turn motor on for 5 seconds	_____
5. Reverse direction of motor	_____
6. Turn on motor for 12 seconds	_____
7. Return car to starting point	_____

*Use a LEGO wire to connect car to test port to see if it will move? (page 9) When it works plug it in port as shown on Activity Card. Go to computer and follow directions to get to the Command Center. Type in commands you just wrote.

*When you have the "bugs" worked out, demonstrate for the teacher to obtain up to 40 points credit.

Teacher's signature: Construction _____ Programming _____

8. How far does your car go when you type "onfor 20"?

9. What should you type if you want your car to go forward 5 feet?

10. How can you change the speed of your car? Hint: See page 40

LEGO® Traffic Light

*Get Activity Card #2 for the traffic light. Pick out the parts as shown in step 1, then assemble those parts. Do the same for step 2, continue until light is complete.

*Study pages 8-12 in "Getting Started", go to computer and get cursor to Command Center.

Turn to page 16 and follow directions for plugging lights into ports. Experiment with commands on page 17, 18 and 19.

Write a program for these messages:

MESSAGE	COMMAND
11. Talk to red light	_____
12. On for 5 seconds	_____
13. Talk to yellow light	_____
14. Repeat light flashing on for two seconds, off for one second, twice	_____
15. Talk to green light, on for 5 seconds	_____
16. Start red light flashing, on for 2 seconds, off for 1 second "forever"	_____

*When you have the "bugs" worked out, demonstrate for the teacher to obtain up to 40 points credit.

Teacher's signature: Construction _____ Programming _____

Turn to page 28 to learn about sensors and answer the following questions.

17. To what does an optosensor respond? _____
18. To what does a touch sensor respond? _____

*You can use a touch sensor to control the traffic light. Follow directions on page 29.

19. What happens when you plug in the touch sensor and type in "listen to 6," and then press the sensor? _____
20. What happens when you type "show sensor"? _____



Product and Personal Quality Assessment Activity 2 - Make a Hydraulic Robot

- 4 - Excellent** (student successfully completes activity & displays mastery of subject/content)
- 3 - Good** (student completes activity with good quality)
- 2 - Needs Improvement** (student completes activity without demonstrating mastery of subject matter or activity performance requirements)
- 1 - Not Acceptable** (student does not yet successfully complete the activity, needs additional work)

Note: This assessment is a combination of a product (how good is the robot?) and personal attitude quality (how good was your work?). This tool can be used for self, peer, or instructor assessment. For each item, circle the rating which most accurately represents your evaluation of the item.

Product Quality

- | | | | | |
|--|---|---|---|---|
| 1. Accuracy of individual component fabrication. | 4 | 3 | 2 | 1 |
| 2. Quality of joint fit. | 4 | 3 | 2 | 1 |
| 3. Care taken on individual component appearance and quality. | 4 | 3 | 2 | 1 |
| 4. Overall appearance of the completed robot. | 4 | 3 | 2 | 1 |
| 5. Overall workability and function of the robot. | 4 | 3 | 2 | 1 |

Personal Qualities

- | | | | | |
|---|---|---|---|---|
| 1. Overall concern for craftsmanship. | 4 | 3 | 2 | 1 |
| 2. Worked effectively with other students during the project. | 4 | 3 | 2 | 1 |
| 3. On task throughout the project. | 4 | 3 | 2 | 1 |
| 4. Amount and quality of improvements, modifications, and enhancements built into the robot. | 4 | 3 | 2 | 1 |
| 5. Safety consciousness. | 4 | 3 | 2 | 1 |



Instructor Resource

Extending Mind and Muscle

Content Outline

1. Introduction to Robotics and Associated Terms
2. Types of Joints
 - Rotational
 - Revolving
 - Twisting
 - Linear
 - Orthogonal
3. Robot Configurations
 - Cartesian coordinate
 - Scara
 - Polar coordinate
4. Robotic Power Systems
 - Hydraulic powered pick and place robot
 - Electrical powered mobile arm robot
 - Adding sensors
5. Robotic Programming
 - Coordinate programming
 - AML
 - Lead through
6. End Effector
 - Design
 - Types
7. Uses of Robots
 - Processing
 - Materials handling
8. Discussion of Impacts of Robotic Technology

Instructional Resources

Books

- Hunt, D. V. (1983). Industrial Robotics Handbook. NY: Industrial Press. ISBN # 0-8311-1148-8.
- McComb, G. 99 Inexpensive Robotics Projects, Robot Builder's Bonanza
- Marsh, P. (1985). Robots New York: Cresset Books.
- Potter, T. How to Make Computer-Controlled Robots, London: Usborne.
- Potter, T., Guild, I. (1983) Robotics, London: Usborne.

Magazines

- Robotics Age, Robotics Publications; P.O. Box 358; Peterborough, NH 03458 (contains hands on activities).
- The Technology Teacher, ITEA monthly publication.

Video

- Robots, an Important Place in American Industry, Meridian Ed. Corp., Dept. VC92, Bloomington, IL 61701 \$79 (10 min.)
- Engineering: The Science of Robotics, Cor-rell Communications Co., 9104 Olive Blvd., St. Louis, MO 63132. Free loan for classroom use. (15 min.)

Software

- Industrial Robots Part I, Robotics Control Systems, Robotics Fundamentals, History of the Robot, Career Opportunities in Robotics, Robotics Issues and Dilemmas, Shopware Educational Systems, 101 Hill Road, Aberdeen, WA, 98520-7302 (Good presentation of fundamentals.)
- Robot and Robot Assembly Lab, Hearlthy & Co., 714 West Columbia St. Springfield, OH, 45501.
- Robot Assembly Lab, Hearlthy & Co., 714 W. Columbia St.; P.O. Box 869; Springfield, OH 45501.
- LEGO Logo ® Provided with LEGO Interface and construction kit. (Excellent manuals.)



Glossary of Terms

AML - A Machine Language, a programming language for robots.

Automation - The automatic control of a process by a machine.

Axis - The point where one part is fixed to another as in a joint.

CAM - Computer aided manufacturing.

End effector - A gripper, or other tool, fixed to the wrist of a robot arm so it will be able to do a particular job.

Hydraulic system - Uses a liquid under pressure to transmit power.

Lead through programming - Programming by manually moving the robot's arm through the desired path. The controller captures the movements into memory.

Pick and place robot - A robotic arm that can pick up objects and move them to another place.

Pneumatic system - Uses air, or some other gas, to transmit power.

Production cell - An area where one robot serves several work stations. Also called work cell.

Program - A sequence of instructions given to a computer, or other controller, to control a robot's movements.

Robot - A reprogrammable, multifunctional device that can move something. (Experts do not all agree on an exact definition.)

Robot Configurations - Various combinations of robot joints combine to form configurations. The most common are scara, polar, cylindrical, Cartesian coordinate and jointed arm.

Sensors - A device which gives a computer information about its surroundings.

Working envelope - The total space in which a robot moves in all directions.

Safety Factors

- Students should never touch the wire on the Styrofoam cutter. The wire gets hot in a few seconds and stays hot until turned off.
- Do not pick up a piece of plastic that has just been melted by the hot wire. It will be very hot.
- Do not touch the melted hot glue from the hot glue gun to avoid burning your skin.
- Safety glasses should be worn when using the Styrofoam cutter to help keep the fumes out of one's eyes.
- Clamp material securely before using a fly cutter. Keep hands out of path of fly cutter.

Instructional Suggestions

Motivation

- Demonstrate small mobile robots that respond to sensors (toys or electronic kits).
- Arrange for demonstrations as suggested in spin-off activities.
- Develop a working robot for some activity around school or home.
- Contact local newspaper to cover "new" activities.
- Pick and Place Contest—arrange a competition to see which robot team can pick and place 10 blocks of foam rubber, or other soft objects, from one spot to a designated area in the shortest amount of time.
- Design contest—challenge students to redesign the robot so that it will fit in a 12" x 12" x 12" box and still lift an object five inches and move it twelve inches horizontally.
- Plan a display of the robots or a demonstration in the lunch room or other appropriate place to help publicize your technology program.
- Enter one of the robotic events at the Missouri State Exposition.
- Have students bring in pictures or new articles for bulletin board.
- Take a field trip to an industry which uses robots.

Prerequisite Information

- Safe and correct use of computers.
- Safe and correct use of drill press and disc sander.
- Principles of power transmission.

Demonstrations

- Demonstration of parts of a robot and explanations of terms if the worksheets and software programs are not used.
- Safe and correct use of hot wire cutter and hot glue gun for hydraulic robot construction.
- Safe and correct soldering techniques for electrically powered robot.
- Use of grommet set.

Academic Enrichment

- Have students make only the end effector or arm for a robot if time, equipment or skill level is a problem.
- Provide independent study for students interested in developing advanced robotic operations.
- Have students write a description of how a robot works to be used in entering technology/science fairs.
- Suggest trying to add another axis to either robot.
- Have art students design robots. Use pictures to identify parts.
- Have dance or drama students choreograph a dance routine for a robot.



Related TAMS

- The Introduction to Materials and Processing Guide
TAM 11 Robotics
- Introduction to Energy and Power Guide
TAM 9 Fundamentals of Fluid Power
TAM 11 Electric Motor Control - Robotics
TAM 17 Applying Electric Motors
- 1990 Implementation Workshop TAMS
TAM 8 LEGO® Energy and Power Activities
- 1991 Implementation Workshop TAMS
TAM 3 Pneumatic Applications
- Performance Standards Project
TAM 11 Basic Electronics

Assessment/Evaluation Suggestions

- Several assessment activities are provided in the hydraulic robot activity. These would need little modification to be used in the electrically powered robot activity.
- A writing assignment about an experience, although not a popular assignment, is great because it requires one to organize and express their thoughts. Technical writing is an important skill to develop. However, to be successful students need guidance in the process and pre-writing activities as is done in language arts classes.

Notes: Review the assessment items which are presented throughout the Performance Standards TAMS for ideas which can be adapted for this TAM. You should also refer to the Performance Standards Implementation Handbook for additional assessment examples and ideas.

Answers to Exploring Robotics Worksheet:

1. Reprogrammable multifunctional manipulator designed to move materials, parts and tools.
2. Where movement occurs.
3. Pattern made by the robots ability to reach and move.
4. A robot that has a gripper that picks up an object and places it.
5. Computer aided drafting.
6. Computer assisted manufacturing.
7. Welding, painting, assembling, installing engines, handling materials, moving objects.
8. Work in toxic poisonous areas and do heavy lifting.
9. Production cell or work cell.
10. Arm, gripper, controller.
11. Hydraulic, pneumatic and electric.
12. Hydraulic is powered by fluid under pressure. Pneumatic is air under pressure.
13. Avoids danger from sparks and can lift very heavy objects.
14. Gripper.
15. Magnetic, vacuum grippers, sticky fingers.
16. Operate the robot arm from existing programs.
17. Repair and maintain the robots and controls.
18. Change the original assignments of the robots and reprogram the robots.
19. Design the robots and/or add computer interfaces to them.

Answers to Lego® Logo Worksheet:

1. Computer
2. Sensor
3. TALKTO "A"
4. ONFOR 50
5. RD
6. ONFOR 120
7. RD ONFOR 70
8. (Variable)
9. (Divide answer from #9 into 60, divide that answer by 2)
10. Reverse gears at rear of motor.
11. TALKTO 1
12. ONFOR 50
13. TALKTO 2
14. REPEAT 2 [ONFOR 20 WAIT 10]
15. TALKTO 3 ONFOR 50
16. FLASH 20 10
17. Light
18. Touch or pressure
19. Green light goes on under port 6.
20. Either true or false shows on computer monitor.

Summary

The construction and operation of a robot provides experiences in processing information, solving construction problems, exploring power transmission, communicating ideas, programming, developing hypotheses and testing them. These experiences are designed to help the students recognize the impact of robotic technology on the work force of the future and to prepare them to assume roles as responsible and productive members of that work force.

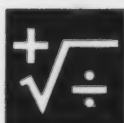
By Steve Murray



The Material for the 21st Century

Goal

The purpose of this module is to introduce students to the world of plastics. Module text and activities will provide experiences with materials science and the manufacturing processes used in industry. Students will construct plastic product manufacturing machines and then produce products using these machines.



Mathematics



Communications



Science



Social Studies



Fine Arts



Health



Technology

Performance Standards

- Speculate on the uses of plastics, including composites and space-age materials.
- List and describe the various applications of plastics technology, including everyday, specialized, and future uses.
- Recognize, analyze, list and describe the potential positive and negative impacts of the increased use of plastics on students, their future employment, and society.
- Demonstrate safety procedures when working with plastics and when using the tools associated with constructing a plastics project.
- Identify typical applications in which plastics are effectively used in industry.
- Develop a design for and solve problems related to constructing a simple plastics project.
- Communicate orally, visually, and/or in writing the principle of plastics, including materials, processes, chemical composition, and structural data.
- Demonstrate proper care and safe handling of all plastics and equipment.
- Identify the various foundation skills for different career options in plastics.
- Define those materials, practices and terms used in plastics, including vacuum forming, injection molding, rotational molding, plasticols, thermosets, and thermoplastics.



Introduction

There was a time when "made out of plastic" meant "cheap" or "poor quality." Times have changed! Look at automobiles, hi tech aircraft, electronics devices, stereos, camcorders, walkmans, CD players, etc. Most of what you use everyday is full of plastics. We now know that plastics are durable, lightweight, extremely formable, and available in a huge array of colors and textures.

During this module, you will be introduced to the basic principles of Plastics Science and Technology. You will learn about plastics in the larger context of materials science. You will also learn how materials science is applied to create and alter plastics. Module units will provide hands-on activities for applying technology to the manufacturing of plastics and plastic products. The activities in this TAM will help you gain an awareness of how plastics are used in common items you use everyday.

Objective Statement

The activities described in the following pages represent samples of activities which can be used to deliver the performance standards on page 1. Many additional activities can and should be used. Extreme care should be taken to connect each activity with appropriate activity objectives as well as with the performance standards. These objectives should be developed by the instructor and should be shared with and made clear to the students.

Plastics Science



Integrated Activity Ideas

Write a technical report explaining your solutions to two design problems which need to be solved while preparing to make a product from plastic.



Technology Idea

Investigate possible career options in the plastics field. If available, visit a local company where plastics forming processes are used. Interview a manager and a technician to explore the types of jobs available as well as the kinds of skills and educational background necessary. Also, inquire into their projections of the job trends for the future in plastics related areas.

Polymer and Technology

Plastics technologies are very exciting and expanding areas of growth. Gone are the days when things made of plastic were said to be "cheap" and of poor quality. Major advances in polymer science have transformed plastics into a highly desirable and valued material for a huge array of applications. It is rapidly replacing glass as the material for containers for liquids and mechanical parts. Recent developments allow for plastics to serve many of the purposes originally restricted to metals. As you read about Polymer Science, you should become aware of the products made from plastics and how plastics are affecting your life and the world that you live in.

Material Science

The atomic theory states that all materials are made up of tiny particles of matter. These tiny particles of matter are called atoms. Each atom consists of electrons (located on shells) and a nucleus (neutrons and protons). See Figure 1.

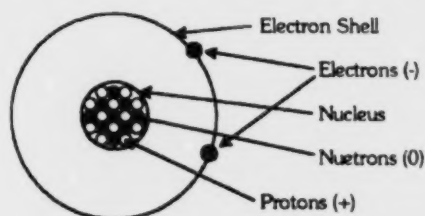


Figure 1- Atom

Since atoms cannot be broken down without losing their identity, the various kinds of atoms represent the most basic materials, otherwise known as elements. Each element is shown on the Periodic table of Elements. This table provides information about each element such as the atomic weight and number.

An element is a fundamental substance containing only one kind of atom. It cannot be broken down into simpler substances by chemical means. For example, pure oxygen contains only oxygen atoms. However, elements can be joined to make other substances. These substances are called compounds. A compound is a distinct or pure substance formed by the chemical union of two or more elements. A compound has properties which are different from the properties of any of the original elements; however, the compound does retain some of the traits of the original elements. For example, carbon unites with oxygen to form carbon dioxide. The carbon dioxide compound is different from both oxygen and carbon. The third part of atomic matter is the molecule. A molecule is the smallest particle of an element or compound which is capable of retaining chemical identity with the substance in mass.



As stated earlier, the electrons are located on shells that surround the nucleus. The motion of these electrons resembles that of our solar system. The electrons located on the outermost shell (valence shell) have the weakest bond to the nucleus. Because of this fact, elements exist in three forms: solid, gas, or liquid. When two or more atoms interact with each other, their electron structure is altered and forms a bond.

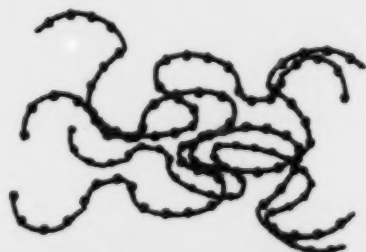
Atomic Bonding

Atomic bonding is dependent upon the number of valence electrons available for the bonding process. Valence electrons are those electrons that exist on the outer shell and are free for bonding. Atomic bonding occurs in three basic forms.

1. Covalent bonding is when molecules are formed from two bonded atoms. Actually, covalent bonding occurs when electrons are shared.
2. Ionic bonding occurs when electrons are interchanged between atoms.
3. A third type of bonding is metallic bonding. This type of bonding occurs only with a metal atom. The valence electrons are donated to an electron cloud. Metallic bonding results in a structure. In polymeric bonding, the structure results in repetitive chains.

Types of Polymer Chains

Atomic theory and bonding creates material structures. These structures are formed as repetitive patterns known as polymer chains. All polymer chains begin as molecules of the same size. These molecules are referred to as monomers (meaning one part). The monomer is a simple compound that will react under certain conditions to form a polymer chain. There are basically two types of polymeric structures. Each type is shown below. (Figure 2)



Continuous Chain



Cross-linked Chains

Figure 2 - Polymer Chains



Integrated Activity Idea

Review the process by which atoms are combined into compounds. Make a model of one of the plastics compounds.



Technology Idea

Conduct strength comparison tests of various types of plastics against each other and against other materials such as wood, metal, ceramics, composites, etc. Then discuss the advantages and disadvantages of various materials for selected products such as chairs, auto parts, toys, speakers, etc.



Integrated Activity Ideas

Compare the relative density of the various types of plastics using the formula

$$\text{Density} = \frac{\text{Mass (Kg)}}{\text{Volume (M}^3\text{)}}$$

Types of Plastics

The types of plastics are directly linked to the polymer chains. All plastics belong to one of two groups of plastics:

- **Thermoplastics:** the thermoplastics are plastics whose structure consists of long chains of atoms linked together as continuous chains. Thermoplastics can be melted and reshaped. Its creation process is called addition polymerization. Basically, the plastic is melted by heat and solidified by cooling.
- **Thermoset:** thermoset plastics are plastics whose structure consists of cross-linked chains of atoms. This crosslinked structure produces plastic with structure that is rigid and strong. Thermoset plastics cannot be melted and reshaped. Thermosets are created through a catalyst-based curing process. Additional heat does not affect the thermoset once its base material has cured.

Examples of thermosets and thermoplastics & their applications are listed below:

Thermoplastics

Polypropylene	Containers, pipes, packaging, battery boxes, etc.
Polyethylene	Packaging, toys, flexible bottles, tubing, insulators, etc.
Polyvinyl Chloride	Pipes, tiles, phonograph records, etc.
Polystyrene	Food containers, kitchen utensils, appliance housings, etc.
Polycarbonate	Safety glass lenses, cams, electrical components, etc.
Cellulosics	Lamp shades, auto parts, fabric coatings, etc.



Integrated Activity Ideas

Conduct a historical investigation into the first uses of plastics materials. What were the difficulties? What kinds of products were the first to be made of plastics?

Thermosets

Phenol Formaldehyde	Tool housings, appliance handles, auto body parts, etc.
Polyester	Fabrics for bags, tarps, etc.
Amino	Switch cover plates, dinner plates, appliance housings, etc.
Alkyd	Enamels, finishes, electrical insulators, etc.
Epoxy	Coatings, adhesive, encapsulation, etc.
Silicone	Sealer, valves, gaskets, etc.

The type of plastic chosen is dependent upon the product and the properties needed for that product. For example, disposable plates do not need to be long-lasting, thus Styrofoam is used for the product material. Advantages of plastics include being lightweight, break resistant, dependable, and long lasting. The atomic structure of each material makes its characteristics unique to certain applications. These characteristics are known as material properties.



Material Properties

Properties can be defined as qualities or traits that belong only to that particular material. Properties can be placed into five categories:

- **Chemical:** Chemical properties deal with a material's reaction to exposure to certain chemicals.
- **Thermal:** Thermal properties relate to a material's reaction to heat. Heat is usually measured in Fahrenheit or Celsius.
- **Electrical:** Electrical properties are those concerned with a material's ability to conduct electricity; that is conductors and insulators.
- **Optical:** Optical properties are those characteristics relating to transparency & reflection.
- **Mechanical:** Mechanical properties involve a material's ability to withstand physical forces or stress. Mechanical properties are determined by measurement of stress. Stress can be found with the following formula.

Most materials can possess several different mechanical properties (or strengths). Some of these properties are listed below.

Tensile - stretching strength

Compressive - squeezing strength

Shear - cutting strength (scissors)

Torsion - twisting strength

Impact - sudden stress strength

These properties are important because all materials are not strong in the same way. One of the most important decisions facing designers is matching the type of material to the kind of strength needed.

Plastic Processing

Manufacturing processes for plastics are numerous and are different for various types of plastics. These basic processes include injection molding, extrusion, blow molding, compression & transfer molding, calendaring, rotational, thermoforming sheet, casting, coating, and laminating. Each of these are described below:

- **Injection molding process** includes forcing a softened plastic through a nozzle that serves as an opening for a mold cavity. After the part has solidified, the part is removed and material runner systems are removed.
- **Extrusion processes** draw plastic through a die to form the finished product.
- **Blow molding** is the process of forcing air into heated plastic tubing and forcing the plastic to take the shape of the mold.



Integrated Activity Idea

Compile a list of numerous plastic products. Then tell why you think they were made of plastic. What were the primary decision-making criteria? Practical, economic, environmental?



Technology Idea

Show students a piece of paper, sheet metal, plywood and glass. Ask them to identify the strongest material. After students have "voted" discuss their reasons. What are the implications for why some products are made from the materials they are? Discuss some real life examples.



Integrated Activity Idea

Select a variety of products which are made with plastic. What kinds of design features have been included to enhance the appearance of either the plastic or the product? In general, are products made of plastic appealing or not? Why?

- **Compression** is where a softened plastic sheet is forced to take the shape of a mold because of pressure created by the mold halves coming together.
- **Calendering** is the process of compressing a softened plastic between rollers to form a continuous sheet.
- **Rotational molding** is the process of filling a hollow mold with a powdered resin and rotating the mold while the resin is heated. Eventually the resin takes the shape of the mold and solidifies during a cooling process.
- **Thermoforming** is the process of forcing a softened plastic sheet to take the shape of a mold. The force is created through air pulling or pushing the sheet.
- **Casting** is the process of pouring softened plastic material into a mold and allowing it to solidify.
- **Coating** is the process of applying plastic to the surface a product. An example is vinyl coating on the handles of hand tools like pliers.

Summary

Industrial plastics have revolutionized product manufacturing and the materials used for those products. During the early 1900's, glass was the material used for almost all containers. Today, plastics have literally replaced glass as the base material for most shelf-based products. The only products that have been loyal to glass as a base material are cosmetic and perfume bottles. Do you know why?

This text introduced you to the world of plastics and its material science. You learned about the basics for material science, its relationship to plastics, material properties, and how plastics are used in industry. As you have discovered, plastics have a lot to offer to the manufacturing industry. Perhaps someday you will become a materials engineer and discover a new material that will replace plastic.

Materials Needed

Pencil or pen and paper



Activity 1

Apply Plastisol Dip Molding

The most common use of plastisol dip molding is to coat handles and insulate metal products. Basically, there are two types of plastisol dip molding: heated and cold. Both types are fairly equal in quality and frequency of use.

This activity will consist of applying plastisol to the handles of hand tools (pliers, cutters, scissors, etc.) and creating a product using plastisol. The steps are provided below for both heated plastisol dip molding and cold dip plastisol.

Procedure

Heated Plastisol Dip Molding

1. Preheat the mold to 350 deg. F for 10 minutes using an oven.
2. Place the heated mold in a container of plastisol for approximately two (2) minutes.
3. Remove the mold from the plastisol container at a constant rate to obtain a smooth surface. As you are removing the mold, allow excess plastisol to drip back into the plastisol container. **Instructor's Initials**
4. Place the mold back into the oven at 350 deg. F for 8 minutes for finishing curing.
5. After curing, remove the mold from the oven and immerse the mold into water.
6. If the mold is the type that requires removal of the plastisol, use a knife to slice an opening in the plastisol that is covering the mold.
7. Pry the opening apart and remove the plastisol part from the mold.
8. Use a knife to trim and finish the plastisol product.

Cold Dip Plastisol Molding

(Products include handles of hand tools, kitchen utensils, etc.)

1. Place the mold in the plastisol container for the time specified by the plastisol manufacturer.
2. Remove the mold from the plastisol container and allow the plastisol to cure.
3. After curing, trim away excess plastisol and complete final finishing.



Integrated Activity Idea

Examine the product information sheet for hazardous materials. Make a presentation to the class about precautions which should be taken to protect individual and environmental health.



Integrated Activity Idea

Remember that you are working with extremely hot plastic material. Wear protective clothing and safety glasses at all times. Keep your mind on task and use caution when handling the materials.



Technology Idea

Numerous products can be made using plastisol. Make a coin purse, a key holder, or a keeper box.



Technology Idea

Manufacture toy cars
(vacuum formed body,
plastic cast wheels with
plastic dip for traction).

Materials Needed

Materials

Heated

Heat curing Plastisol

Primer (used for permanent attachment of plastisol to the mold)

Material for mold

Coat hanger wire (used for mold handle)

Cold

Air curing Plastisol

Material for mold (if necessary)

Coat hanger wire (used for mold handle or handling hand tools)

Equipment

Heated

Laboratory Heating oven with air circulating fan and temperature range up to 500 degrees.

Cold

Hand tools for shaping, creating, and handling the mold



Activity 2

Apply Plastic Casting

Plastic casting is used for producing solid plastic products. The process is very similar to casting used in the steel industry. Possible products include clear plastic casting of wall & shelf ornaments, embedded plastic cast, etc. During this activity, you will create a plastic product by designing & building a mold and casting plastic. Basic steps are indicated below:

1. Select a plastic product for manufacturing. (see Technology Idea)
2. Create a mold for the plastic cast. Pre-existing molds can be purchased from a technology education vendor or they can be made. Molds can be made from any number of material types, including wood, glass or metal. One idea would be to make a key-chain using a CNC mill, an NC mill or even a router to make the pattern. Remember, casting molds need to be made as mirror-images of the final desired product. (See Figure 3.)

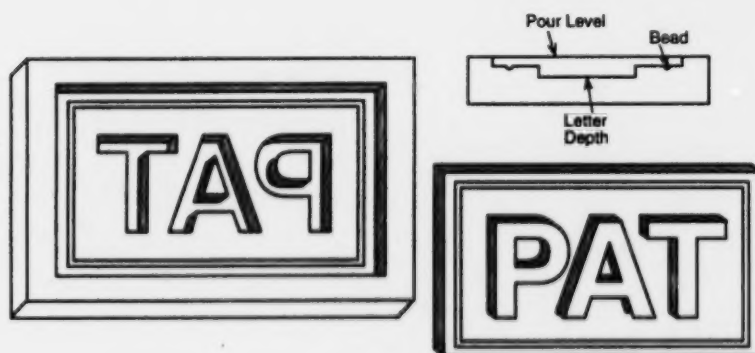


Figure 3 - Mold

3. Apply thin coating of mold release to the inside surfaces of the mold.
Instructor's Initials
4. Pour the plastic cast resin into a measuring cup. (NOTE: It is important to use the exact amount of plastic cast to eliminate waste.)
5. If color is desired, add color dyes to the plastic cast resin.
6. Apply the specified amount of plastic cast resin catalyst.
7. Slowly mix the plastic cast resin & catalyst. Do not allow air bubbles to form within the mix. **Instructor's Initials**
8. The plastic mix should be poured into the mold until the mix reaches the desired level.
9. Allow curing time as specified by the plastic cast manufacturer.



Technology Idea

Products which you can make using plastic casting include a key chain charm with your school's mascot on it, paper weights, wall ornaments and lots more. You can also imbed other objects into clear plastic moldings. See vendor catalogs for more ideas. (Instructor Component).



Integrated Activity Idea

Develop an illustrated presentation (video, slides, cutaways, drawings, etc.) which describes the plastic casting process. Include the sequence of steps necessary to complete a product. Include as many real life products descriptions as you can think of.



**Technology
Idea**

*Manufacture cups, bowls,
kitchen utensils, etc. for
school cafeteria.*

Materials Needed

Materials

Liquid plastic resin
Plastic Cast Catalyst
Color Dyes (if desired)
Mixing sticks

Clear Plastic Cast
Mold Release for Plastic Casting
Measuring cups

Equipment

Plastic Cast Mold
Hand tools for making molds



Activity 3

Apply Plastic Bead Molding

Foam plastics are formed by adding air to plastic resin and creating a sponge-like plastic. These plastics are typically used for packing padding and product support during shipping & handling. Basic methods for plastic foaming are mechanical (formed by continuous shaking), physical (uses compressed gases mixed with plastic), and chemical (uses chemical compounds to create a gas that mixes with the plastic). This activity will introduce you to the technology of plastic foam molding. The basic steps for plastic foam molding are listed below.

Procedure

1. Create or obtain a mold for expandable foam molding. One idea is to make polystyrene foam cups (or even larger containers). The mold is made either by using a purchased mold or by making one from aluminum (cast and then machined on a lathe). A cross section of a cup mold is shown in Figure 4 below.

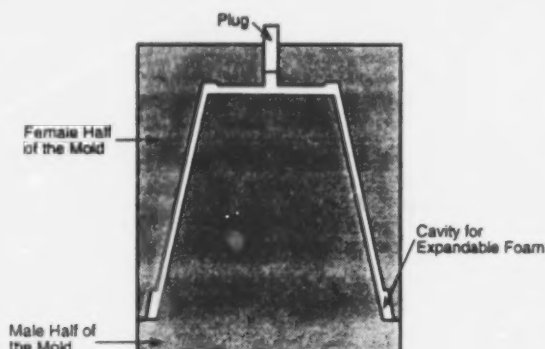
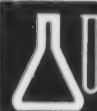


Figure 4 - Cup Mold

2. Pre-expand the polystyrene beads by placing the beads into boiling water.
Instructor's Initials
3. Place the pre-expanded polystyrene beads into the mold.
4. Join the mold halves together and securely fasten. Heat the mold with boiling water for the time specified by the expandable bead manufacturer. (NOTE: The time & temperature are critical for proper foaming.)
5. After expansion & mold cooling, remove the foam product from the mold.



Integrated Activity Idea

Consult with a science teacher about the chemical processes which occur in typical foam plastic molding processes. Pay particular attention to any hazardous chemical reactions which could occur as part of the process.



Technology Idea

Things you can make using foam molding include product packaging castings, foam cups, and foam plates. Molds are available from vendors. But why not make one of your own with the school mascot or some other graphic molded into it? This could be a great club money raising project!

Materials Needed

Materials

Expandable polystyrene beads

Measuring cups

Equipment

Heat device for boiling water (e.g. hot plate)

Expandable foam mold

Container for holding water for mold cooling



Activity 4

Constructing & Using a Blow Molding Machine

Blow molding is used for making bottles and plastic containers. Its basic process consists of a tube being placed between two mold halves and as the halves are closed together, the bottom end of the tube is clamped shut. Immediately following the mold halves coming together, air is forced into the open end of the tube until the tube takes the shape of the mold. After the blow molded product is cooled, it is removed from the mold. This activity will allow you to create a blow molding device and create a blown-molded product. The following describes the basic steps.

Procedure

1. Select a product that you wish to blow mold (bottles, containers, etc.).
2. Prepare two-part mold from hard maple using available tools. (NOTE: Use dowel rods for guide pins to align the mold halves.)

Instructor's Initials

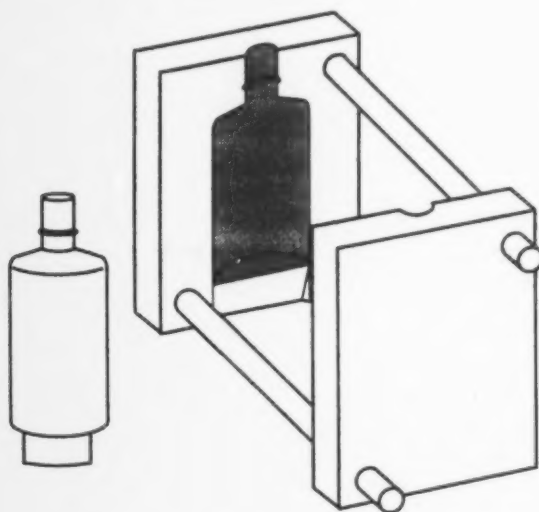


Figure 5 - Blow Molding

3. Glue the pins into place.



Integrated Activity Idea

Make a video which illustrates the history of procedures used and products made using blow molding. Clips from glass blowing and small children blowing bubbles could be included. Synchronize with music.



Integrated Activity Idea

Make an animated video short of the blow molding process.

4. Create an opening in one end of the mold to allow forced air into the tube. (NOTE: The other end of the mold should be used to clamp the tube closed.)
5. Shape the mold cavities to the proper form of the chosen blow-molded product.
6. Sand the cavities to a smooth surface.
7. Apply a coat of epoxy to the cavity surfaces.
Instructor's Initials
8. Cover the exterior of the mold with two coats of finish.
9. Wax the guide pins and place the mold halves together.
10. Obtain a clamping device for holding the mold halves together.
11. Heat the plastic tubing (parison) at 325° F for approximately 5 minutes.
12. Place the parison in the mold and clamp the mold halves together securely. (NOTE: One end of the mold should be open and the other end should clamp the parison closed.)
13. Use an air compressor to force air into the parison. Air pressure should equal 30 to 40 psi. Maintain pressure for 5 to 10 seconds.
14. Allow cooling time and remove the product from the mold.

Materials Needed

Materials

High density polyethylene tubing (1/16" wall thickness)
Hard maple for mold
Epoxy finish for mold cavity
Lacquer or Polyethylene finish for mold exterior
Brush
Copper wire for handling the parison

Equipment

Air compressor with air gun nozzle
Hand tools for shaping the mold and mold cavity
Drill & bits for placing guide pins (dowels)
Knife for cutting plastic tubing
Oven for heating the plastic tube (parison)



Activity 5

Constructing & Using a Vacuum Forming Machine

Thermoforming is one of the most popular and oldest processes used for plastics. It consists of using heat and pressure to force a plastic sheet to take the shape of the mold cavity. Vacuum forming uses air pressure to force the shaping of the plastic sheet. Typical applications include plastic shells for protecting products, packaging, car bodies, etc. During this activity, you will construct a vacuum forming machine and design a product & its mold for vacuum forming. The basic steps are outlined below:

Procedure

1. Select a product for vacuum forming (model car body, bowls, sorting trays, light switch cover, speaker boxes, etc.).
2. Create a one-part mold from hard maple and shape the mold cavity or product form.
3. Sand and finish the mold cavity with epoxy finish.
4. Finish the exterior of the mold with polyurethane finish.
Instructor's Initials
5. Place 1/8" vent holes in the one-part mold at various locations. The bottom of the mold should have a cavity to allow air suction to reach all vent holes.
6. Create a vacuum box (with a lid & latch) to house the vacuum mold. The vacuum box should be rectangular and slightly larger than the mold. (NOTE: The vacuum box should have an opening in the bottom to allow air pressure to pull the plastic sheet to the shape of the mold. The opening in the bottom should be the same size as the nozzle on the Shop Vacuum.)
7. Open the vacuum box and place the high impact polystyrene sheet inside the vacuum box chamber. The sheet should be placed over the mold.
Instructor's Initials
8. Heat the polystyrene sheet with a heat gun until it becomes rubbery.
9. Close the vacuum box lid and seal shut.
10. Place the shopvac nozzle in the vacuum box opening (in the bottom of box) and begin air suction. Air suction should be maintained for a few seconds (until the plastic sheet cools).
11. Remove the vacuum formed product from the vacuum box.
12. Trim the excess plastic from the product.



Technology Idea

Take a field trip to a company that uses this vacuum molding process. Watch it in action. Have the design people describe the mold making process as well as the design features which they must use. These machines are really interesting to watch!



Technology Idea

Use the vacuum forming process to "blister pack" objects. This would be an ideal way of putting "a wrap" on a mass production activity!

Materials Needed

Materials

High Impact Polystyrene sheet (.060 in. thick) - available from Cope Plastics
(see Instructor Manual)

Hinges

Wood for mold and vacuum box

Latch

Equipment

Shop Vacuum with hose & nozzle

Heat gun

Hand tools for shaping mold & vacuum box

Drill & bits for creating vent holes

**Assessment****Scoring Rubric for Activity 5 - Vacuum Forming**

Performance Standard	Wgt %	Exemplary 2 pts.	Acceptable 1 pt.	Not Yet Acceptable 0 pts.	Sub total
I. Creative Thinker					
Speculate on the uses of plastics, including composites and space-age materials.	x.5	Student writes a technical memo speculating on the future of vacuum forming materials with no errors.	Student writes a technical memo speculating on the future of vacuum forming materials with 2 or less errors.	Student writes a technical memo speculating on the future of vacuum forming materials with 3 or more errors.	2 x .5 = 1
List and describe the various applications of plastics technology, including everyday, specialized, and future uses.	x.5	Student correctly lists and describes 3 everyday products for which vacuum forming is responsible.	Student correctly lists and describes 1 everyday product for which vacuum forming is responsible.	Student does not correctly list and describe any everyday products for which vacuum forming is responsible.	2 x .5 = 1
II. Critical Thinker					
Recognize, analyze, list, and describe the potential positive and negative impacts of the increased use of plastics on students, their future employment, and society.	x.5	Student correctly lists and describes on a written exam 3 positive and 3 negative impacts of the increased use of plastics.	Student correctly lists and describes on a written exam 1 positive and 1 negative impacts of the increased use of plastics.	Student does not list or describe on a written exam any positive or negative impacts of the increased use of plastics.	2 x .5 = 1
III. Contributing Citizen					
Demonstrate safety procedures when working with plastics and when using the tools associated with constructing a plastics project.	x2	Student practices all safety procedures at all times.	Student practices all safety procedures while under the direct supervision of the teacher.	Student does not practice all safety procedures regardless of the supervision level.	2 x 2 = 4
IV. Self-Directed Learner					
Identify typical applications in which plastics are effectively used in industry.	x.5	Student correctly identifies 3 applications of vacuum forming in industry.	Student correctly identifies 1 application of vacuum forming in industry.	Student does not correctly identify any applications of vacuum forming.	2 x .5 = 1
V. Problem Solver					
Develop a design for and solve problems related to constructing a simple plastics project.	x2	Student designs and solves problems for the vacuum mold with limited assistance from others (2 or less situations).	Student designs and solves problems for the vacuum mold with average assistance from others (3-5 situations).	Student designs and solves problems for the vacuum mold with constant assistance from others (more than 5 situations).	2 x 2 = 4
VI. Effective Communicator					
Communicate orally, visually, and/or in writing the principles of plastics, including materials, processes, chemical composition, and structural data.	x1	Student correctly presents to the class a diagram depicting the complete vacuum forming process.	Student presents to the class a diagram depicting the complete vacuum forming process with 1 error.	Student presents to the class a diagram depicting the complete vacuum forming process with 2 or more errors.	2 x 1 = 2
VII. Quality Producer					
Demonstrate proper care and safe handling of all plastics and equipment.	x2	Student demonstrates proper care and safe handling of all equipment at all times.	Student demonstrates proper care and safe handling of all equipment while under the direct supervision of the teacher.	Student does not demonstrate proper care and safe handling of all equipment at all times.	2 x 2 = 4
VIII. Technical Foundations					
Identify the various foundation skills for different career options in plastics.	x.5	Student correctly lists 3 foundation skills on a written test.	Student correctly lists 1 foundation skill on a written test.	Student does not correctly list any foundation skills on test.	2 x .5 = 1
Define those materials, practices and terms used in plastics, including vacuum forming, injection molding, rotational molding, plastics, thermosets, and thermoplastics.	x.5	Student correctly defines materials, practices, and terms on a written test with 90% mastery.	Student correctly defines materials, practices, and terms on a written test with 70% mastery.	Student correctly defines materials, practices, and terms on a written test with less than 70% mastery.	2 x .5 = 1

Total: 20 out of 20 Possible

Review Questions- Activity 1

1. Describe the atomic theory and its relationship to polymers. _____

2. Draw and diagram the basic parts of the atom.
3. Explain the types of atomic bonding for materials. _____

4. What is a polymeric chain? _____

5. What are the two basic types of polymeric structures? _____

6. Distinguish between thermoset plastics and a thermoplastics. _____

7. Describe the four basic mechanical properties for materials. _____

8. List the basic processes used in the manufacturing of plastic products. _____

9. Select a plastic manufacturing process and research its basic process & prepare a chart that illustrates the process.



Mastery Checklist

Yes	No	
		Define technological terms associated with Industrial plastics, plastic processes, and polymeric science.
		Sketch and label the basic parts of an atom.
		Differentiate between matter, atom, molecule, compounds, and elements.
		Describe the concept of atomic bonding.
		Draw and diagram the basic types of polymeric structures.
		State the basic types of polymers.
		Distinguish between a thermoset plastic and a thermoplastic.
		Illustrate four mechanical properties for industrial plastics.
		List and explain four basic processes for plastic product manufacturing.
		Construct a device that will apply a plastic process to the production of a plastic product.
		Design a plastic product and the mold for producing the product.
		Utilize a plastic manufacturing machine to produce a plastic-based product.

Product Quality Checklist - Activity 5

4 = Excellent, 3 = Good, 2 = Needs Additional Work, 1 = Not yet Acceptable

	Overall quality of mold design
	Quality of mold's working drawings
	Workmanship of individual mold components
	Quality of mold assembly
	Ingenuity and problem-solving ability shown in mold and product design process
	Mold and product design process.
	Product quality (crisp edges and lines, surface finish, plastic thickness uniformity.)
	Trimming and finishing quality.

By Steve Murray



Instructor Resource

The Material for the 21st Century

Content Outline

1. Introduction
2. Material Science
 - Atomic Theory (Atoms)
 - Electrons, Neutrons, and Protons
 - Nucleus
 - Elements
 - Compounds
 - Molecule
 - Atomic Bonding
 - Ionic
 - Covalent
 - Metallic
 - Types of Polymer Chains
 - Continuous
 - Cross-Linked
3. Types of Plastics
 - Thermoset
 - Polyester
 - Amino
 - Alkyd
 - Epoxy
 - other
 - Thermoplastic
 - Polypropylene
 - Polyethylene
 - Polystyrene
 - Cellulosics
 - other
4. Properties
 - Chemical
 - Electrical
 - Thermal
 - Optical
 - Mechanical
 - Tensile
 - Compression
 - Shear
 - Torsion
 - Impact
5. Plastics Processing
 - Injection molding
 - Extrusion
 - Blow molding
 - Compression & transfer molding
 - Calendaring
 - Rotational
 - Thermoforming sheet
 - Casting
 - Coating
 - Laminating

Instructional Resources

Books

- Andres, C. K., Smith R.C. (1988) Materials of Construction. New York, NY: McGraw-Hill Book Company.
- Baird, Ronald J. and Baird, David T. (1986) Industrial Plastics. South Holland, Illinois: The Goodheart-Willcox Company, Inc. 1986
- Kazanas, H.C., Klein, R. S., Lindbeck, J. R. (1979) Technology of Industrial Materials. Peoria, Illinois: Bennett & McKnight Publishing Company.
- Missouri Introduction to Materials & Processing Technology Guide. (1989) Columbia, MO: Instructional Materials Laboratory.
- Natter, H. Tam, T. Y. (1975). How to Work with Plastics and Equipment (Illustrated). Honatech Press. ISBN 0-0600930-0-1.

Video/Slides/Film

"Introducing Plastics Technology" available from: Meridian Education Corporation, 236 E. Front St., Bloomington, IL 61701. Phone: 1-800-727-5507

Industry and Associations

Dow Chemical Co.
2030 Dow Center
Midland, MI 48674

GenCorp
175 Ghent Rd.
Fairlawn, OH 44313

Rubbermaid, Inc.
Akron Rd.
Wooster, OH 44691

Society of Plastic Engineers
14 Fairfield Dr.
Brookfield Ctr., CT 06805

Activity Suppliers

Brodhead-Garrett Co.
223 S. Illinois Ave.
Mansfield, OH 44905
1-800-321-6730



Cope Plastics, Inc.
4441 Industrial Drive
Godfrey, IL 62035
1-800-835-0686

IASCO
(Industrial Arts Supply Co.)
5724 W. 36th St.
Minneapolis, MN 55416
1-612-920-7393

Faxton/Patterson
5719 W. 65th St.
Chicago, IL 60638
1-800-323-8484

PITSCO
P.O. Box 1328
Pittsburgh, KS 66762
1-800-835-0686

SATCO
924 S. Nineteenth Ave.
Minneapolis, MN 55404
1-612-370-2555

AIN Plastics
249 E. Sanford Blvd.
P.O. Box 151
Mt. Vernon, NY 10550
(914) 668-6800

Glossary of Terms

Addition polymer - a polymer formed by a chain reaction

Addition polymerization - polymerization of monomers by a chain mechanism involving active centers on the growing chains

Alloy - composite material made by blending polymers or copolymers with other polymers or elastomers under selected conditions

Annealing - a process of holding a material at an elevated temperature below its melting point to permit stress relaxation without distortion of shape

Blowup ratio - the ratio of the mold cavity diameter to the parison diameter

Cast - to form a plastic object by pouring a fluid monomer-polymer solution into an open mold where it finishes polymerizing

Catalyst - a substance which speeds up the polymerization or cure of a compound when added in minor quantity as compared to the amounts of primary reactants

Cavity - depression in a mold made by casting, machining, hobbing, or a combination of these methods

Charge - the measurement or weight of material used to load a mold at one time or during one cycle

Creep - the dimensional change with time of a material under load

Copolymer - a polymeric system which contains two or more monomeric units

Cross-linking - the formation of primary valence bonds between polymer molecules

Deflashing - the finishing technique that removes excess on a plastic molding

Density - weight per unit of volume of a substance

Draft - the degree of taper of a side wall or the angle of clearance designed to facilitate removal of parts from a mold

Elastic - ability of a material to return to its original shape after stress is applied

Elastomer - a material which at room temperature stretches under low stress to at least twice its length and snaps back to the original length upon release of stress

Filler - a cheap, inert substance added to a plastic to make it less costly

Fillet - a rounded filling of the internal angle between two molding surfaces

Flash - extra plastic attached to a molding along the parting line which must be removed before the part can be considered finished

Flow - a qualitative description of the fluidity of a plastic during molding

Gate - the orifice through which the melted plastic enters the mold cavity

Laminated - a composite plastic consisting of layers

Mold - to shape plastic parts or finished articles by heat and pressure; cavity where plastic material is added to take shape

Orifice - the opening in the extruder die

Parison - the hollow plastic tube from which a container is blow molded

Parting line - mark on a molding or casting where halves of mold meet in closing

Plasticity - the ability of a material to be nonelastically deformed without fracturing

Polymer - a high molecular-weight organic compound, natural or synthetic, whose structure can usually be represented by a repeated small unit, MER

Polymerization - a chemical reaction in which the molecular weight of the molecule formed is a multiple of the original substances

Preform - a preshaped plastic material to be used in mold

Premix - materials in which the resin, reinforcement, extenders, fillers, etc., have been prepared before molding

Resin - any of a class of solid or semisolid organic products of natural or synthetic origin

Rib - a reinforcing member of a fabricated or molded part

Runner - the channel that connects the sprue with the gate to the mold cavity

Sprue - feed opening provided in the mold

Stress crack - external or internal crack in a plastic caused by tensile stresses

Thermoplastic - plastic material capable of repeated softening by heat and hardened by cooling

Thermoset - a plastic material that is formed by a chemical reaction by the action of heat, catalyst, light, etc.

Viscosity - internal friction or resistance to the flow of a liquid

Safety Factors

Safety plays a key role in any Technology Education activity. During this module, the student should follow safety procedures associated with school lab activity. Students must wear safety glasses during all machine operations. Extreme care should be taken when working with heated plastics.



Instructional Suggestions

Motivation

- Display several different plastic products and discuss the type of plastic used in the product.
- Have students contact, and if possible visit for a tour or demonstration, several industries and associations that use plastics.
- View the plastics video.
- Arrange for a field trip to a plastics manufacturer.
- Have a plastics manufacturer visit the class to talk about entrepreneurial opportunities in the plastics field.
- Conduct a "plastics scavenger hunt" where objects made of various types of plastics and plastics processes are "found."
- Alert students to the excellent career possibilities in plastics.

Prerequisite Information

- Some background in basic chemistry is not mandatory, but would be very desirable.
- Some background in basic materials science.
- Ability to use basic hand and machine tools.

Demonstrations

- Each of the plastic processing devices and procedures should be demonstrated to students prior to the use of the devices to produce plastic products.

Academic Enrichment

- Advanced students could pursue the chemical properties of polymers in more depth.
- Have students conduct destructive testing on various types of plastics.
- Conduct comparison tests of plastics vs. other types of materials.
- Design and construct a bridge out of plastics. Test the bridge against those constructed from other materials for comparative purposes.

Related TAMS

- Introduction to Materials & Processing Technology Guide
 - TAM 4 Fiberglass Fabrication
 - TAM 5 Non-Destructive Testing
- 1990 Implementation Workshop TAMS
 - TAM 14 Materials Properties Testing
- Performance Standards Project
 - TAM 14 Mass Production and Manufacturing

Assessment/Evaluation Suggestions

- Develop a list of quality criteria for each of the products which are to be constructed in this activity. Use this as a product assessment.
- Develop a set of criteria for the devices to be constructed in the activities. Transform this into an information sheet to guide students in constructing and evaluating the quality of the device.
- Have students select material from this unit to include in their portfolio. This could include answers to activity #1 questions, or photos of products or machines made in the TAM, or a video of processes performed.
- Arrange for students to do peer and self assessment of both the quality of their products as well as other areas such as teamwork, being on-task, quality of ideas, etc.
- Assign a team of 4-5 students to develop a plastic product using one of the five basic processes explored with this module. Then use both a process and product scale to assess their work.
- Pay special attention to assessing problem solving and creativity in this TAM since there are large numbers of potential products which could be made with the various forming processes.
- Involve students in the process of developing scoring rubrics which will be used for peer, self and instructor assessment.

Note: Review the assessment items which are presented throughout the Performance Standards TAMS for ideas which can be adapted for this TAM. You should also refer to the Performance Standards Education Implementation Handbook for additional assessment examples and ideas.

Summary & Review

During this module, students were introduced to the world of plastics. Students read about plastics technology, processes, and applications. Students also created plastic products and processing machines to explore the plastics industry. As a wrap-up for the module, the instructor should review the following:

- Material Science
- Atomic Bonding for plastics
- Types of plastic chains
- Types of plastics: Thermoset & Thermoplastic
- Examples of plastics
- Types of Plastics Processing



What Makes the Light Go On?

Goal

The goal of this TAM is to look at how electrical energy is produced from mechanical energy. Using basic laws of magnetism and a simple permanent magnet motor, students will make observations and collect data that can be used to determine the efficiency and output of the system.

Performance Standards

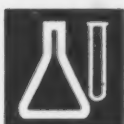
- Speculate future applications of and advances in electronics technologies based on assessments of current trends.
- List and describe the various applications of electronics technology, including everyday, specialized, and future uses.
- Recognize and analyze the potential positive and negative impacts of the increased use of electronics on students, their future employment, and society.
- Comprehend how electronics technology impacts and affects society and the everyday lives of its citizens.
- Practice all safety procedures when interacting with electronics and when using the tools associated with electronics.
- Develop a design for and solve problems related to constructing electronics systems.
- Communicate orally, visually, and/or in writing the basic principles of electronics.
- Demonstrate the ability to work with specialized electronics equipment, including that used for testing, modeling, and simulation.
- Demonstrate proper care and safe handling of all electronics equipment.
- Identify the various foundation skills for different career options in electronics.
- Define basic terminology which is used in electronics.



Mathematics



Communications



Science



Social Studies



Fine Arts



Health



Technology



Introduction

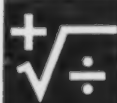
With the development of a system for building and maintaining fire, using organic growth to produce heat energy for cooking and stay warm, humans embarked on a long journey that takes one form of energy and converts it to another. The longer we have been around, the more sophisticated these technologies have become. In this TAM we will take a look at one of the most widely used sources used to produce electrical energy, mechanical energy. As you work through this TAM, it is important to realize that the method for producing the mechanical energy itself is an energy conversion. Sources of mechanical energy are muscle power, wind, water, nuclear, etc. All can be used to produce mechanical energy, which is then converted to electrical energy. There is no one to one conversion. In the process of converting, energy is lost and by-products are produced. The amount of loss determines how efficient that system of conversion is. You should ask yourself, "Can we develop a system in which there is no loss? What factors would be needed to do this?"

Objective Statement

The activities described in the following pages represent samplers of activities which can be used to deliver the performance standards on page 1. Many additional activities can and should be used. Extreme care should be taken to connect each activity with appropriate activity objectives as well as with the performance standards. These objectives should be developed by the instructor and should be shared with and made clear to the students.

Activity 1

Tips and Hints...



Integrated Activity Idea

Whenever possible, team up with a math or science teacher to get their input and emphasis on the topics and activities.

On Magnetism, Electromagnetism, Motors, Generators and the Like

You may have done the following mini-activities in other classes. It will be helpful to do these before moving on to other activities in this TAM. Information in these activities will be used to explain concepts in the following activities.

Start-Up Activity 1

Viewing Magnetic Flux Lines and Pole Polarity of a Permanent Magnet and an Electromagnet

Arrange magnets on table or poster board so that magnet fields are (1) attracting and (2) repelling. You may wish to use the compass to identify the pole of the magnets before arranging them. You may find it necessary to tape or glue the magnets to the surface so they do not move. Position the poles .5 to .25 inches apart. Place transparency film or paper over the magnets and sprinkle iron filings over top of magnets. You will see flux lines form. Observe how they interact when magnet fields repel and attract each other.

Now place the sheet over the top of the electromagnet and sprinkle the iron filings. No flux lines should be seen. Connect the coil of wire to the lantern battery and repeat the above procedure, showing flux lines forming around an electromagnet in the same way they do around a permanent magnet. Using the compass, show that the magnet field around the poles of an electromagnet changes when the leads from the battery are reversed.



Technology Idea

Investigate the variety of careers available in electronics and electronics related areas. Consult the Dictionary of Occupational Titles (D.O.T.) for specific information. If available, visit with an instructor in a local AVTS or a Technology Education teacher who specializes in electronics to find out what options are available and what education and training are required. Remember, electronics related careers are definitely among the fastest growing and most challenging in this current climate. Check it out!

Materials Needed

Pair of permanent magnets
Coil of wire (30 feet of 22 to 28 AWG motor wire wrapped around a 20 penny nail)
6 volt lantern battery and two leads
Iron filings (lay magnet behind bench grinder to collect these)
Sheet of transparency film or sheet of white paper
Compass
Hot glue or tape



Start-Up Activity 2

Voltage Inducted Into a Coil of Wire by a Magnet

To construct a simple galvanometer, cut a piece of poster board as wide as the compass's diameter and as long as the compass's diameter plus twice its height. On both ends of the long dimension mark a line equal to the height of the compass. Note that the compass should lay neatly between these two lines. Fold the ends of the cardboard up to a 90 degree position so that the compass is cradled between the two ends. Place the compass in the cradle so that the north and south poles point to the folded ends. Wind 100 turns of the wire around the compass in the north/south direction, leaving the ends at least 12 inches long. Twist the ends together so that the wire does not unwind. Scrape about .5 inches of the enamel insulation from the end of the two wires and attach the alligator clips. When a small amount of current flows through the wire, the compass needle will tend to swing in an east/west direction. The stronger the swing, the greater the current.

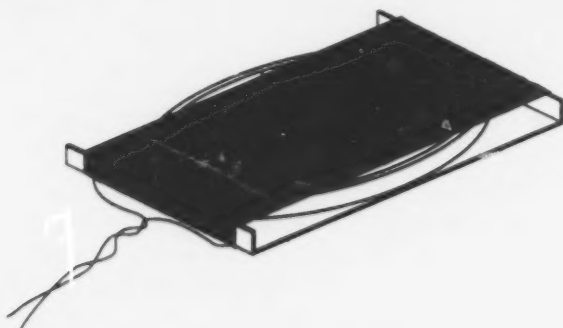


Figure 1 - Homemade Galvanometer

Connect your galvanometer to the coil (Fig. 1). Rapidly pass the magnet over the coil in a direction that is parallel to the nail. The needle should swing in an east/west direction indicating a current flow. You now have a voltage generator. Three components to a voltage generator are a magnetic field, a coil of wire, and some type of relative motion between the two.



Integrated Activity Idea

Experiment with 200 turns of the wire. How many paper clips will the magnet lift now, compared to when it had 100 turns?

Materials Needed

A galvanometer or the material to build a simple one

Compass

Piece of poster board

Magnetic wire 28 AWG or finer

2 alligator clips

Permanent magnet

Coil of wire (see above)

Start-Up Activity 3



Integrated Activity Idea

Write a paragraph on how it feels to wait for a shock, get a shock, and what causes a shock.



Integrated Activity Idea

Conduct an investigation of the role electrical impulses play in the human brain and nervous system.



Integrated Activity Idea

Research the hazards of electricity, including safe levels of amperage and voltage.

Inductive Kick and Series and Parallel Battery Connections

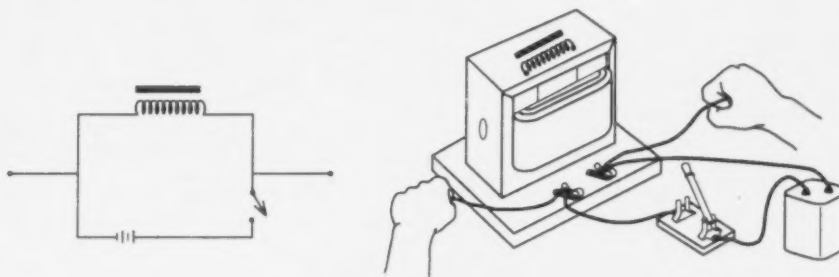


Figure 2 - Inductive Kick Circuit

Wire the circuit in Figure 2. This circuit gives an inductive kick (shock) to the persons completing the circuit by holding both leads. If you can control the excitement, you can teach series and parallel battery connection to a large group of students by forming a circle and having them hold hands. Have students connect the batteries in series and then in parallel and have them report on the intensity of the shock. In this way, the concept that voltage increases in series circuits and voltage remains the same in parallel circuits, can be taught through experience.

Materials Needed

5 to 10 henry inductor
6 volt lantern battery
4 (four) 1.5 volt batteries
12 (twelve) clip leads



Math & Term Review

Throughout the remaining activities it will be very important to understand the meaning of some key terms. If a clear idea of these terms and their mathematical relationships are not present, measurements and conclusions will have little meaning. Please review these and research any which may not be familiar to you.

Terms:

Voltage is pressure that causes the flow of electric current. Unit of measure is the volt. Mathematical symbol is V or E.

Current is the rate of flow of electrons in a circuit. Electrons move from the negative pole to the positive pole. Unit of measure is the ampere (amp). Mathematical symbol is I or A.

Resistance is the opposition to the flow of current in a circuit. Unit of measure is the ohm (Ω). Mathematical symbol is R.

Power is the rate of doing work, or the rate of energy conversion. Unit of measure is the watt. Mathematical symbol is P or W.

Ohms Law is a set of mathematical formulas that express the relationship between current, voltage, and resistance in an electric circuit.

Watts Law is a set of mathematical formulas that express the relationship between current, voltage, and power in an electric circuit.

Efficiency is an expression of how much energy is lost when converting energy from one form to another.

Percent regulation is the change in voltage occurring at the output terminals of a power source between no-load and full-load.

Mathematical Formulas:

Ohms Law

$$V = I \times R \quad I = V/R \quad R = V/I$$

Watts Law

$$P = I \times V \quad I = P/V \quad V = P/I$$

Efficiency

$$\text{Output/Input} \times 100 = \% \text{ efficiency}$$

Percent Regulation

$$\% \text{ regulation} = (\text{no-load } V - \text{full-load } V) / \text{no-load } V \times 100$$

Where: V=Voltage, I=Current, R=Resistance in Ohms, P=Power



Integrated Activity Idea

Write a report on James Watt, Thomas Edison, Georg Simon Ohm or other pioneers from the electronics field. What did they do or discover that was so important? What and/or who helped them? How much of the "discovery" was new and how much was an adaptation from earlier knowledge? How much would say was science and how much was technology? Discuss the difference between the two.



Integrated Activity Idea

How are Ohm's Law and Watt's Law used in science?

Activity 2



Integrated Activity Idea

Prepare a written report describing how a motor works using correct terminology.



Integrated Activity Idea

Prepare and deliver a speech explaining how an electric motor works.



Integrated Activity Idea

Do historical research into the development of the first motors. Include some of the first applications for which they were used. How did these uses change society?

Dissection & Operation of Permanent Magnet Motor

Small permanent magnet motors are used in a variety of locations in the home. The best source of these motors is motorized toys that have been used and discarded for loss of interest or failure to work. Removal of the motors not only provides an inexpensive source of materials (motors, gear boxes, wheels, and etc.), but also provides an opportunity to learn how things are put together. In addition, the topic of recycling materials and equipment and how industry makes use of once used materials may be addressed.

In this activity each student will identify the parts of a permanent magnet motor and the function of that part in the overall operation of the motor. If care is taken, the motor may be reassembled and used in the following activities. If the student is unable to acquire a recycled motor, one may be purchased at Radio Shack or obtained from any number of mail order stores.

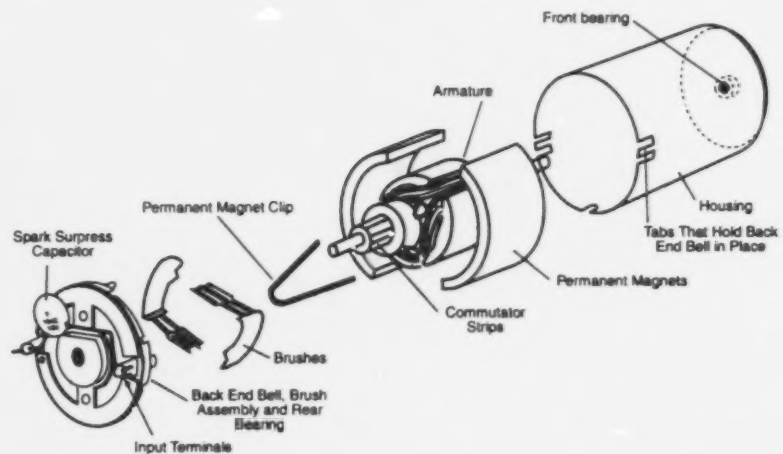


Figure 3 - Permanent Magnet Motor (Exploded)

Procedure

1. Examine the motor and remove any gears or pulleys that are on the shafts. Most of these gears and pulleys are press-fitted and will slide off with a minimum of force.



2. Identify the input terminals that allow the power to be connected to the motor.

Note: If the motor came out of an old toy it may have a small disc capacitor connected to the input terminals. The purpose of this capacitor is to reduce spark noise at the brushes so that operation of the motor will not interfere with radio and television reception.

3. Locate the tabs that hold the back of the motor to the body and straighten them using a screwdriver or other sturdy tool. Carefully bend them back and remove the back of the motor.
4. Examine the brush assembly. Of what are the brushes made? How are the power connection terminals held in place?
5. Remove the armature (In AC motor this is called a rotor). Identify the commutator strips and armature windings. How many armature windings are there? How many commutator strips are there?
6. Examine the main body of the motor (stator). This holds the permanent magnets that form the magnetic field. How are these magnets held in place? Using a compass identify the magnet field orientation. Are the two magnets identified in any way?
7. What type of bearings are in the stator? What type of bearings are in the back (brush assembly) of the motor?
8. Place the armature in the bearing on the back plate that contains the brush assembly. Open the brush assembly so that it slips over the commutator. Force could damage the brushes. Once in place rotate the armature and observe how the commutator and the brushes form a rotary switch.
9. Carefully reassemble the motor by reversing the order above and test run. Be very careful when replacing the brush assembly. Do not bend or break the brushes. Make sure that they make contact with the commutator.

Materials Needed

1 DC permanent Magnet Motor



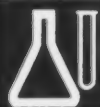
Technology Idea

Use a CAD system to draw a complete component-by-component diagram of a motor.



Integrated Activity Idea

Draw a motor and identify its parts. Then include in your illustration a brief description of what the various parts do (the functions they perform).



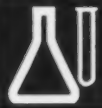
Integrated Activity Idea

Explore the manufacturing and the metallic composition of the permanent magnets used to make these motors with the assistance of your chemistry teacher.

Activity 3

The Motor Generator (MG) Set

(Principles of Generators and How They Work)



Integrated Activity Idea

Review of the three principals necessary for the operation of generators. These have a direct tie to physics.

The law of energy conservation states that energy can neither be created nor destroyed; therefore the total amount of energy in the universe remains constant. Energy is lost whenever energy is converted from one form to another. A discussion of this occurrence has direct relationship both scientifically and technologically.



Integrated Activity Idea

Michael Faraday is considered to be the "Father of the Dynamo (generator)." He lived from 1791-1867. What was going on in the world during this period of history? How was Faraday's work viewed at the time?

In this activity you will use two permanent magnet motors, mounted on a block of wood, and coupled together so that when the shaft of one turns, the other will turn also. One motor will supply the mechanical energy needed to turn motor two. The second motor's armature will turn in a magnetic field and produce electrical energy that will be used to illuminate the light bulb.

Procedure

1. Hot glue the two motors to the blocks of wood. The end of the motor shaft should be even with the short dimension.

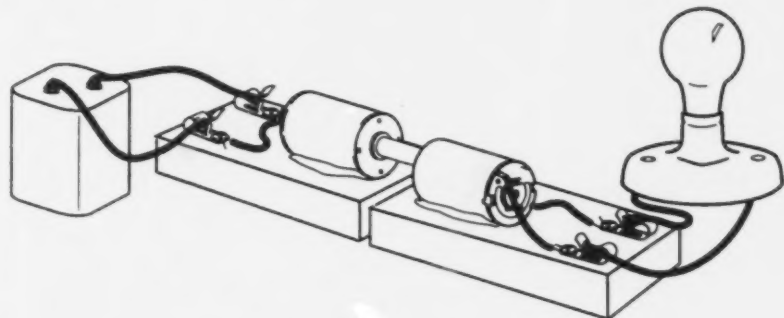


Figure 4 - Motor-Generator Set

2. Using No. 4 sheet metal screws 1/2 in length, mount two fahnestock clips to the wood block. Do not tighten these down at this time. Locate the fahnestock clips toward the back of the motor.
3. Remove 1/2 Inch of insulation from both end of two 3 inch pieces of hookup wire. Solder one end of each piece to the terminals of each motor and place the other end under the fahnestock clip and tighten the clip.

Instructor's Initials

4. To test each motor connect it to a six volt lantern battery, by using the clip heads.
5. Slide approximately 1 inch of insulation off a piece of 14 AWG wire.



6. Slide the insulation onto the shaft of one motor and then the next. This forms a mechanical link between the two motors.
7. Place a small dab of hot glue under each motor's wooden block. Mount on a smooth flat surface so that the shaft of both motors do not bind.
8. Connect the 6 volt lantern battery to a motor. Start and run the motor. This drive motor should also be turning the second motor.
9. Using screws/hot glue mount the lamp socket to a block of wood. Connect the terminals from the lamp socket to a set of fahnestock clips in the same way as the motors above.

Instructor's Initials

10. Using a pair of clip leads, connect the lamp to the terminals of the second motor, to the terminals of a 6 volt lantern battery or to the power supply in activity six.

Note: The first motor should slow down and the filament of the lamp should light. If the filament does not light, it may be necessary to connect a second battery in series with the first (positive terminal of battery one to negative terminal of battery two) or increase the voltage output of the power supply.

Materials Needed

2 DC motors
1 inch of insulation from a 14 AWG wire
1 lamp and socket (3-6 volts)
6 fahnestock clips
hook up wire
4 clip leads
soldering iron and solder
hot glue gun and glue sticks
3 wood block (3/4 x 2 1/2 x 4)
2 six (6) volt lantern batteries or the variable power supply from activity 6

Activity 4

Series/Parallel Circuits Using the MG Set



Technology Idea

In this activity motor one provided the mechanical energy needed to turn motor two (the generator). What other ways can this mechanical energy be supplied? What are some of the problems connected with other sources?



Technology Idea

Take a field trip to the nearest power generation plant in your area. After returning, prepare a flow chart of the process and write a technical report which describes the process.

This activity requires no special electronics testing equipment. Results of procedures are simply observed rather than tested with specialized equipment.

Procedure

Light Bulbs Connected in Series

1. Mount and connect the MG set (motor-generator) as described in activity 3.
2. Using the clip leads, connect four light bulbs in series.
 - a. Connect terminal one of lamp one to terminal one of lamp two;
 - b. Connect terminal two of lamp two to terminal one of lamp three;
 - c. Connect terminal two of lamp three to terminal one of lamp four.
3. Connect terminal two of lamp one to one of the terminals on the generator and terminal two of lamp four to the remaining terminal on the generator.

Instructor's Initials

4. Begin operating the motor. It may be necessary to connect two or more 6 volt lantern batteries in series to get the speed of the motor to light the filament of the four bulbs. If you are using the variable power supply from activity 6, simply increase the voltage.
5. Answer the following questions about light bulbs connected in series.
 - a. Remove one light bulb, what happened?
 - b. Connect a clip lead across the terminals of the light bulb that you removed; what happened?
 - c. Does the MG set work harder with three light bulbs or four; why does this happen?

Light Bulbs Connected in Parallel

6. Remove all clip leads from the light bulbs from the above circuit and connect the light bulbs in parallel as follows:
 - a. connect terminal one, lamp one, to terminal one lamp two;
 - b. connect terminal one, lamp two, to terminal one lamp three;
 - c. connect terminal one, lamp three, to terminal one lamp four;



- d. connect terminal two, lamp one, to terminal two, lamp two
 - e. connect terminal two, lamp two, to terminal two lamp three;
 - f. connect terminal two, lamp three, to terminal two lamp four;
 - g. connect terminal one of lamp one to one of the terminals of the generator;
 - h. connect terminal two of lamp one to the remaining terminal of the generator.
7. Connect the batteries or the variable power supply to the motor. It may be necessary to connect two or more 6 volt lantern batteries in series to get the speed of the motor to light the filament of the four bulbs. If you are using the variable power supply from activity 7, simply increase the voltage.
8. Answer the following questions about light bulbs connected in parallel.
- a. Remove one light bulb from the socket. What happened?
 - b. Does the load on the generator increase or decrease with the removal of the lamp? Why?

Materials Needed

2 DC motors mounted on blocks (activity 3)
1 inch piece of insulation from 14 AWG wire
12 clip leads
4 lamps and sockets (3-6 volts)
3 six volt lantern batteries or variable power supply from activity 6

Activity 5

Multimeter Testing of the MG Set

The difference between this activity and the previous one is that this activity requires the use of a digital multimeter.

In the previous activity the sound the motor made told you the difference in operation of the circuit. However, what was happening was not completely clear. In this activity you will see how important instrumentation is to identifying just what happens. From the data that you collect and evaluate you may observe how efficient this MG set is and how much power is produced.

Note: You will need to use the formulas given in page 6, Activity 1 for this activity.



Integrated Activity Idea

Develop a report which is designed to define and then illustrate (with real world devices) each of the following energy and power concepts.

- ♦ energy
- ♦ power
- ♦ instrumentation
- ♦ control

Procedure

1. Connect four lamps in series. (See Activity 4).

Instructor's Initials

2. Use the multimeter to measure and record the input voltage and current to the motor.

_____ volts in

_____ current in

_____ power in (calculate and show your work)

3. Use the multimeter to measure and record the output voltage and current from the generator. Calculate the power delivered to the lamps using the formula from activity one.

_____ volts out (full-load)

_____ current out

_____ power out (calculate and show your work)

4. After disconnecting the lamps from the generator measure the output voltage of the generator.

_____ voltage output (no-load)

5. Repeat steps 2 through 4 for the parallel circuit. Measure, record, and calculate in the space provided below.

_____ volts in

_____ current in



_____ power in (calculate and show your work)
_____ volts out (full-load)
_____ current out
_____ power out (calculate and show your work)
_____ voltage output (no-load)

6. Using the data collected above and the formulas found in activity one calculate the efficiency and percent regulation for the series and parallel circuits. Please show all work.

Efficiency:

_____ Series Circuit
_____ Parallel Circuit

Percent Regulation:

_____ Series Circuit
_____ Parallel Circuit

Materials Needed

2 DC motors mounted on blocks (activity 3)
1 inch piece of insulation from 14 AWG wire
12 clip leads
4 lamps and sockets
1 digital multimeter and leads
3 6v lantern batteries or variable power supply from activity 6

Activity 6

1.2-15 Volt Variable Power Supply 1.5 Amp Output



Technology Idea

Use power supply to run motor for laser light show (spinning mirrors).

To perform the activities in this TAM you will need 3 six volt lantern batteries or this power supply. The cost of this variable supply is around \$15 to \$20 and can pay for itself in a short time. If you want a higher voltage, changing the transformer to 24 volts will increase the output voltage. To get the maximum output current you will need a heat sink for the LM317.

The circuit may be built in two ways: point to point construction on a block of wood or printed circuit board and housed in a case. Voltmeter and ammeter may be purchased and added to the circuit so that readings may be made from the supply.

Note: One free printed circuit board can be obtained from author by sending E-mail message to <droth1@services.dese.state.mo.us> and asking for the printed circuit board for the 1.2 to 15 volt power supply. This offer is good through 1995.

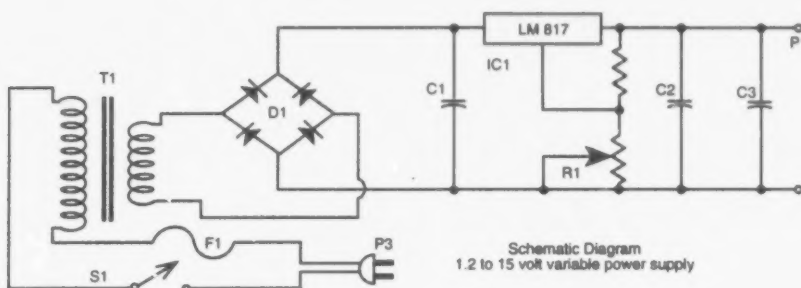


Figure 5 - Schematic Diagram for Power Supply

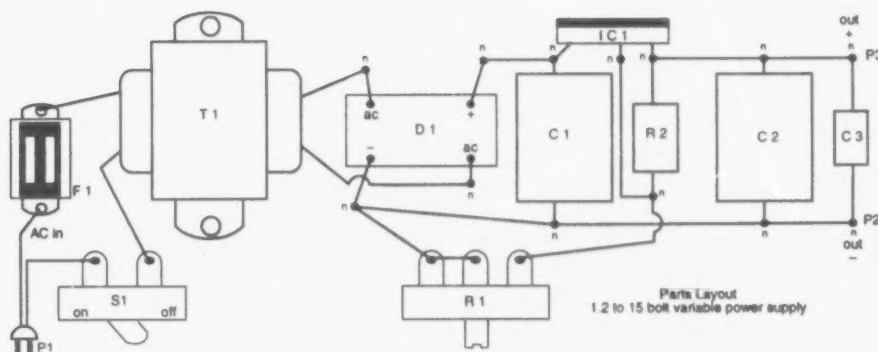


Figure 6 - Pictorial of Power Supply



Materials Needed

- T₁ transformer, 115 volt primary and a 12.6 volt @ 1 amp secondary volts
- C₁ electrolytic capacitor, 2200 micro farad (2200 μ fd) at 50 volts
- C₂ electrolytic capacitor, 100 micro farad (100 μ fd) at 50 volts
- C₃ disc capacitor, .1 micro farad (1 μ fd)
- IC₁ variable voltage regulator, LM317
- D₁ bridge rectifier, 100 volts PIV at 2 amp
- R₁ potentiometer, 5,000 ohms (5K Ω)
- R₂ resistor, 470 ohms (470 Ω) 1/2 watt
- P₁ AC line cord
- S₁ Single Pole Single Throw switch (SPST)
- P₂, P₃ output terminals (fahnestock clips, 5 way binding post, etc.)
- soldering iron and solder
- hand tools (needle nose pliers, diagonal wire cutter, screw drivers, etc.)

Assessment

Scoring Rubric for Activity 4 - Series/Parallel Circuits Using the MG Set

Performance Standard	Wgt %	Exemplary 2 pts.	Acceptable 1 pt.	Not Yet Acceptable 0 pts.	Sub total
I. Creative Thinker					
Speculate future applications of and advances in electronics technologies based on assessments of current trends.	x.5	Student conducts library search on futures of electronics, gathering 5 sources/articles.	Student conducts library search on futures of electronics, gathering at least 3 sources.	Student conducts library search of futures of electronics, gathering less than 3 sources.	2 x .5 = 1
List and describe the various applications of electronics technology, including everyday, specialized and future uses.	x.5	Student correctly lists/describes 3 uses each of series and parallel circuits per instructor/text.	Student correctly lists/describes 1 use each of series and parallel circuits per instructor/text.	Student does not list/describe any uses of series or parallel circuits per instructor/text.	2 x .5 = 1
II. Critical Thinker					
Recognize and analyze the potential positive and negative impacts of the increased use of electronics on students, their future employment, and society.	x1	Student correctly lists/analyzes 3 positive and negative impacts of the increased uses of electronics per the instructor/text.	Student correctly lists/analyzes 1 positive and negative impact of the increased uses of electronics per the instructor/text.	Student does not list or analyze any positive or negative impacts of the increased use of electronics.	2 x 1 = 2
III. Contributing Citizen					
Comprehend how electronics technology impacts and affects society and the everyday lives of its citizens.	x.5	Student correctly discusses how series/parallel circuits impact society per teacher/text with no errors.	Student correctly discusses how series/parallel circuits impact society with less than 3 errors.	Student discusses how series/parallel circuits impact society with more than 3 errors.	2 x .5 = 1
IV. Self-Directed Learner					
Practice all safety procedures when interacting with electronics and when using the tools associated with electronics.	x2	Student practices all safety procedures when working with the series/parallel circuit.	Student practices all safety procedures with the direct supervision of the teacher.	Student does not follow all safety procedures when working with the series/parallel circuit.	2 x 2 = 4
V. Problem Solver					
Develop a design for and solve problems related to constructing electronics systems.	x1	Student designs own circuit and solves all problems her/himself.	Student designs and problem solves with teacher's assistance.	Student does not design or problem solve circuit.	2 x 1 = 2
VI. Effective Communicator					
Communicate orally, visually, and/or in writing the basic principles of electronics.	x1	Student creates an effective technical report of circuit exercise with no errors.	Student creates an effective technical report of circuit exercise with 2 or fewer errors.	Student creates a technical report of circuit exercise with more than 2 errors.	2 x 1 = 2
VII. Quality Producer					
Demonstrate the ability to work with specialized electronics equipment, including that used for testing, modeling, and simulation.	x2	Student correctly constructs circuit with no errors and limited interaction with teacher (less than 2 situations).	Student correctly constructs circuit with no more than 2 errors and no more than 3 interactions with teacher.	Student does not correctly construct circuit or does with excessive interaction with teacher.	2 x 2 = 4
Demonstrate proper care and safe handling of all electronics equipment.	x.5	Student properly and safely handles all circuit equipment.	Student properly and safely handles equipment with teacher assistance.	Student does not correctly and safely handle all equipment.	2 x .5 = 1
VIII. Technical Foundations					
Identify the various foundation skills for different career options in electronics.	x.5	Student correctly defines all skills per teacher/text.	Student correctly defines all skills with 70% accuracy.	Student defines skills with less than 70% accuracy.	2 x .5 = 1
Define basic terminology which is used in electronics.	x.5	Student correctly defines all circuit terms per teacher/text.	Student correctly defines all terms with 70% accuracy.	Student defines circuit terms with less than 70% accuracy.	2 x .5 = 1

Total: 20 out of 20 Possible

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Checkoff List for Activity 6

I. Point to Point Connections (20 pts.)

- ☐ too much solder
- ☐ too little solder
- ☐ stranded wire not tinned
- ☐ cold solder joints
- ☐ too much heat applied to joint
- ☐ wire not clipped close enough

II. Printed Circuit Board Connections (20 pts.)

- ☐ too much solder
- ☐ too little solder
- ☐ stranded wire not tinned
- ☐ cold solder joint
- ☐ too much heat applied to board
- ☐ solder bridge
- ☐ breaks in foil not repaired
- ☐ wire not clipped close enough

III. Parts Placement (20 pts.)

- ☐ all parts read from left to right
- ☐ all parts read from one of two directions
- ☐ all parts installed correctly
- ☐ wires run close to chassis
- ☐ parts mounted too close to P.C. board
- ☐ parts mounted too far from P. C. board
- ☐ wires not neatly run

IV. Project Functions (20 pts.)

- ☐ does not work properly
- ☐ does not work at all

V. Project Case (20 pts.)

- ☐ no case
- ☐ case too large
- ☐ case too small
- ☐ quality of workmanship on case

VI. Project Difficulty (10 pts.)

- ☐ low
- ☐ medium
- ☐ hard

Total points: _____

Study Habit Observation Rubric

- 4 - Outstanding**
3 - Good
2 - Needs Improvement
1 - Poor

Present in Class	4	3	2	1
On time for Class	4	3	2	1
Prepared to Work	4	3	2	1
Attentive to Classroom Work	4	3	2	1
Stays on Task the Entire Period	4	3	2	1
Performs Daily Chores	4	3	2	1
Completes Assignments on Time	4	3	2	1
Works Well in Groups	4	3	2	1
Is a Self Starter	4	3	2	1
Works Well Independently	4	3	2	1
Demonstrates good Organizational Skills	4	3	2	1
Flexible in Thinking (adapts well)	4	3	2	1
Cooperative	4	3	2	1
Responsible	4	3	2	1
Helpful and Considerate of Others	4	3	2	1
Positive Influence	4	3	2	1
Goes Beyond Classroom Assignments	4	3	2	1
Manages Class Time Wisely	4	3	2	1
Uses Knowledge and Information (other than memorize, store, recall)	4	3	2	1
High Level of Concentration (even though other things are going on)	4	3	2	1

Total:

Comments:



Name _____

Affective Self and Peer Assessment

For each of the criteria, assign a rating to each member of the class or technology group (including yourself) on a scale of 4 - 0. (4 = excellent, 3 = good, 2 = average, 1 = poor, 0 = unsatisfactory.)

	Student A	Student B	Student C
Initiative (ability as a self-starter, self motivated)			
Use of time (consistently on task, productive, efficient)			
Reliability (regular attendance, carry tasks through to completion)			
Work quality (tasks and operations were well done)			
Idea quality (good problem solving skills and ideas)			
Ability to work with others (ability to share tasks, contributing team member)			
Overall knowledge of electronics			
TOTALS			

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Instructor Resource

What Makes the Light Go On?

Content Outline

1. Review of principles of magnetism and electricity (activity 1)
2. Safety (differences in)
 - electrical
 - heat
 - mechanical
 - equipment
3. Energy conversion
 - law of energy conservation
 - ways of producing electrical energy
4. Parts of a motor
 - stator
 - rotor
 - armature
 - commutator
 - brushes
 - bearings
 - field coils or magnets
5. Principles of a generator
 - Michael Faraday (1791-1867)
 - magnetic field
 - conductor
 - relative motion between the two
6. Output of a generator
 - speed of rotation
 - strength of magnet field
7. Load characteristics of both series and parallel circuits
8. Use of multimeter to measure
 - voltage
 - current
9. Math review and explanation of
 - watts law
 - efficiency
 - percent regulation
10. Construction practices

Instructional Resources

Books

- Thomas Alva Edison Foundation (1988). The Thomas Edison Book of Easy and Incredible Experiments. John Wiley & Sons, Inc.
- Graf, Rudolf F. (1964). Safe and Simple Electrical Experiments. New York: Dover Publications, Inc.
- Amery, Heather and Littler, Angela (1989). The Know How Book of Batteries and Magnets. Belgium: Usborne Publishing Ltd.

Supplies and Equipment

All materials used in this TAM may be purchased through Radio Shack. Your budget dollars will go farther if purchases can be made through mail order.

Glossary of Terms

Armature - the structure that holds the coils that cut the magnetic lines of force. It is attached to a shaft.

Commutator - found on the armature and forms one part of a rotatory switch that connects the power produced in the rotating armature to the outside world.

Brushes - part of a rotary switch that wipes against the commutator of a motor or generator allowing contact to the outside world.

Law of Energy Conservation - states that energy cannot be created or destroyed; it may be transformed from one form into another, but the total amount of energy never changes.

Efficiency - the ratio of useful work output to total work input, or the percentage of the work put into a machine that is converted to useful work output.

Percent Regulation - the amount of voltage change that occurs at the output terminals of a power source between no-load and full-load.



Safety Factors

- Electric shock
- Proper handtool usage
- Proper soldering techniques
- Staying clear of rotating devices

Instructional Suggestions

Motivation

- Arrange for a field trip to an electric motor repair shop where students can see motors being rebuilt.
- Have someone employed in an electronics related area talk with the class about careers in electronics (maintenance and design technician in an automated manufacturing plant, a radio and TV repair shop owner, etc.).
- Describe the excellent job outlook for those with expertise in electronics.
- Demonstrate and discuss the exciting kinds of things which can be (and are being done) with electronics, such as smart house control, and speaker and sound system design.

Prerequisite Information

- Basic knowledge of electronics

Demonstrations

- How to disassemble and reassemble the permanent magnet motor.
- How to make current and voltage measurements using the multimeter.
- How to solder. The theory of soldering.

Academic Enrichment

- Challenge students to modify a universal motor to operate as an independently excited field generator using a battery or power supply to create the magnetic field.
- Have students design a PC board using a computer program such as Spice or using CAD. Then make the board using photochemical processes. Complete the board by attaching the electrical components.

Related TAMS

- Introduction to Energy and Power Technology Guide
 - TAM 11 Electronic Motor Controlled Robots
 - TAM 12 Instrumentation and Control Revealed
 - TAM 17 Applying Electric Motors
 - TAM 18 Using Electric Instrumentation

- Introduction to Communication Technology Guide
 - TAM 7 On-Line Computer Communication
 - TAM 10 Intercom Systems
 - TAM 11 Home Security Monitoring Systems
 - TAM 12 FM Transmitters
 - TAM 13 Building an AM Radio Receiver
- 1990 Implementation Workshop TAMS
 - TAM 19 The Information Age
- 1991 Implementation Workshop TAMS
 - TAM 18 Fiber Optics Communication: Transmitter and Receiver
 - TAM 12 Communications Via Computer and FAX
- Performance Standards Project
 - TAM 3 Telecommunications/Telephony
 - TAM 6 Smart Houses

Assessment/Evaluation Suggestions

- Assess students using the sample scoring rubric shown on page 18.
- Develop and use scoring rubrics for each activity in the TAM.
- Have students give verbal descriptions of processes or concepts contained in the TAM. This will enable the teacher to ensure comprehension.
- Develop an electronics portfolio containing definitions of key terms, electrical circuits and constructed, and descriptions of systems designed such as speakers, a security system, or an automated temperature control system.
- Use tests as appropriate to assess understanding of basic and essential electronics concepts and ideas.
- Build in plenty of opportunities for formative and in-process self assessment.

Note: Review the assessment items which are presented throughout the Performance Standards TAMS for ideas which can be adapted for this TAM. You should also refer to the Performance Standards Implementation Handbook for additional assessment examples and ideas.

Summary

This TAM was designed to provide technology teachers with a range of electronics related activities (from simple to advanced). Electronics related technical careers and devices are changing our society, our technology and our way of living. Technology education teachers must continue to build their knowledge in this important area.

By Steve McNaught



The Big Picture!

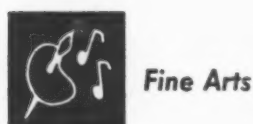
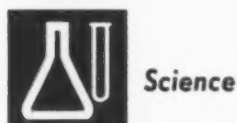
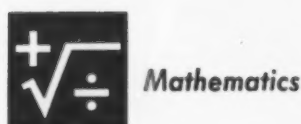
Goal

These activities are designed to give you new perspectives on important and complex environmental and biological issues. You can also gain insight into your own sense of environmental responsibility and empowerment.

These simulation activities display the unity and diversity of life and the interdependence of our natural world. Direct explorations of ecological systems and interactions provide an excellent opportunity for you to deepen your comprehension of this important technological and scientific theme.

Performance Standards

- Analyze a technological activity and describe the four potential environmental impact outputs. Type I: expected desired outputs; Type II: expected undesired outputs; Type III: unexpected desired outputs; Type IV: unexpected undesired outputs.
- Comprehend that technology creates solutions to problems as well as creating additional problems.
- Debate the positive and negative impacts of technology on social values, the government, and individual quality of life.
- Discuss develop and practice a home school, or community recycling program per local guidelines.
- Discuss the ways in which social and cultural values have influenced the technologies which have been chosen for development.
- Identify various career options in environmental-related areas.
- Comprehend the waste stream and society's ways of addressing this problem: Landfills, incineration, recycling, and other alternatives.
- Discuss and illustrate ways in which technology reflects the values of society (e.g., freedom and the automobile).
- Research government agencies and regulations that deal with environmental impacts that are tied to technology.
- Comprehend and discuss the three major technological ages (Agricultural, Industrial, and Informational) of society and assess technology's role in these eras.





Introduction

What Environmental Conditions May Bring About Our Extinction?

These activities have been developed to help you gain an understanding of why the study of the environment and the impacts that technology has had upon it is important. You will examine recent changes in attitudes toward the environment and the causes and solutions of environmental problems.

Some of today's environmental problems stem from misunderstandings and a failure to predict the long range consequences of our actions. These problems can be viewed from many perspectives, and the issues are complicated.

You will practice making careful decisions. You will have to remember that social, political, economic and aesthetic factors, along with scientific and technological concerns, are all intertwined when considering the use of this planet. Everything is connected to everything else.

Our world consists of people, their cultures, and the bio-physical environment. This biosphere is made up of such things as sunlight, water, air, rocks and minerals as well as living things that continually alter the environment in some way or another.

When people change the environment they strengthen, weaken or maintain the ecological system. In order to develop and maintain a quality environment in which all are able to live, we must learn how to plan to preserve what resources the earth now possesses and avoid future destruction of natural resources.

People have the ability to determine, at least to a certain extent, what will happen to the resources on this planet. The resources and energy on this earth are limited. As populations increase, demand for natural resources also increases.

The geologic record of the earth indicates at least four massive extinctions including one, thought to be the largest, that took place about 225 million years ago, and the famous mass extinction that included the demise of the dinosaurs, about 65 million years ago. There are a number of theories as to the causes of these extinctions. One widely considered explanation for dinosaur extinction is a catastrophic asteroid collision, although many other theories have also been suggested.

The spacing of mass extinctions has also led some scientists to assume that it happens once in approximately 26 million years. There is continuing debate on the role played by catastrophe and sudden change, as opposed to more gradual developments that eventually may have led to extinctions. Some biologists suggest that we're on the verge of a fifth mass extinction, citing in particular the impact of changes brought on by man.



Integrated Activity Idea

Obtain and view the video "The Electric Horseman" starring Robert Redford. What issues are raised in the story?



Integrated Activity Idea

Prepare a report on the projected long term effects of global warming and ozone depletion. In what ways is technology being used to solve these problems?



Integrated Activity Idea

Prepare a report on the projected long term effects of water pollution and deforestation. In what ways is technology being used to solve these problems?

Evidence for this theory includes the increasing number of extinct or endangered species, deforestation, the development of nuclear weapons and energy, worldwide problems with air and water pollution, and numerous other issues related to global warming, ozone depletion, and energy use. The environmental crisis raises many questions about the price of advancements in technology, the industrial revolution and the future of our natural environment. Many people wonder whether we are creating the instruments of our own destruction through our technology.

The series of activities presented in this TAM are designed to help you gain new perspectives on these important and complex environmental and biological issues. You can also gain insight into your own sense of environmental responsibility. The interdependence displayed in these simulation activities is concrete experience to aid the understanding of the unity and diversity of life. You will also gain some appreciation for just how interconnected everything in the natural world is. Direct exploration of systems and interactions provides an excellent opportunity for you to deepen your comprehension of this important technological and scientific theme.

Objective Statement

The activities described in the following pages represent samples of activities which can be used to deliver the performance standards on page 1. Many additional activities can and should be used. Extreme care should be taken to connect each activity with appropriate activity objectives as well as with the performance standards. These objectives should be developed by the instructor and should be shared with and made clear to the students.



Activity 1

SimEarth Challenge 1

In these activities, you will use computer simulations to make observations and hypotheses about the effects of changing factors on geologic and biological development.

The geological and environmental conditions of a planet must satisfy certain conditions in order for the growth of life-forms to take place. These conditions and the forces responsible for their development are interrelated and are a complex and dynamic system.

Fossil records document extinction of life forms. Extinction is a natural part of biological development and evolution. Explanations of extinction need to take into account the species that become extinct as well as those that survive.

Humans have had (and continue to have) a profound impact on the Earth. People can choose to change their behavior in order to avoid harming the environment. We share a social responsibility to protect the natural resources of our planet. (Note: The software is also available for use on the IBM platform.)

Software Preparation for Students

Students will need to spend 1-2 hours working with the software to become familiar with the variety of options and variables. In order to enter the program, you must refer to a Planet Specification Sheet at the end of the User's Manual and fill in a requested number. There are nine of these sheets, for the nine planets of the solar system. When you first click on the SimEarth icon, you will be asked to fill in a number, such as the axial tilt of Venus, or the diameter of Mars, or the distance from the Sun to Saturn. The number can be found on the specification sheet for the planet in question. Enter the ID number and press the return key to enter the program. You will need to have access to this part of the documentation. The documentation includes extensive background information and support for the beginner. No special computer skills are needed beyond a general knowledge of the Macintosh. To access on-line help, hold down the Shift key and click on anything on the screen. The Quick Start guide will get you started, and it is an excellent way for you to begin your exploration.

Software Hints

It is particularly helpful to know how to establish a control model of the SimEarth program and how to use the single variable adjustments. As noted above, the Quick Start guide provides step-by-step directions that students may use. You may prefer to give the students enough time to explore more freely and thereby construct their own knowledge and skills through doing and only suggest the Quick Start guide as needed after this initial period of free exploration. Students will also need access to the Planet Specification Sheets and the entire User's Manual.

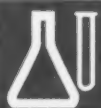


Technology Idea

Check the effects of airborne chemicals on a piece of nylon stretched across a can or bottle and left outside. (You may be surprised at the kinds and amount of sediment/grime that gathers on the nylon.)

Getting Started

Begin with a brainstorming session about extinction. You may want to start with questions about what happened to the dinosaurs. Discuss what you know and believe about the extinction of the dinosaurs.



Integrated Activity Idea

Do a study of a particular species which has become extinct during the last 20 years. Choose one which is native to the U.S., if possible one in your immediate state or region. What caused the species to become extinct? What could have been done to prevent it?

Procedure

The SimEarth Challenge I

Working in groups of two, establish a control model of the SimEarth program and investigate its operation and capabilities. As you do so, remember to keep in mind the questions about extinction from the brainstorming discussion.

To establish a control model, select variables from the Models menu prior to running simulations. Variables may be set for atmosphere, geosphere, biosphere, and civilization. Each team should establish its own control, based on decisions the team members make when setting up the simulation. You can manipulate variables in a variety of ways, starting with the four control panels.

- The **atmospheric control panel** options include air temperature, solar input, greenhouse effect, cloud albedo, surface albedo, and air-sea thermal transfer.
- The **geosphere control panel** allows you to control continental drift, volcanic activity, erosion, meteor impacts, core heat, core formation, and axial tilt.
- The **biosphere control panel** allows you to modify reproduction rate, CO₂ absorption, thermal tolerance, mutation rate and advance rate.
- The **civilization control panel** controls how the model deals with intelligent species and is only useful in the Civilization and Technology Time Scales. With it, one can cause or prevent wars, eliminate unwanted technologies, select various energy sources, establish rival civilizations, and so on.

This general investigation of the SimEarth program is intended to provide you with an opportunity to familiarize yourselves with the procedures, to try various options, and to enjoy the software before taking on more specific challenges.



Integrated Activity Idea

Prepare a report on global warming. Is it real? How serious is it? What is causing it? What are some of the most serious (and realistic) projected outcomes? Do you think they will happen? When? What should be done?



As you select and manipulate variables, record both the anticipated outcome and the simulated outcome as well as any comments you have on the worksheet provided (Activity One Worksheet, Manipulating Variables). You could also develop your own methods for reporting. You could use illustrations, videotaped interviews, dramatic or musical presentations, or other creative means of expressions.

Throughout the process, adjust single variables and compare differences with their baseline model. This helps you begin to develop cause-and-effect patterns to further theorize about what may have happened on Earth in the past. Take ample time to manipulate the variables and use the computer simulation to test your hypotheses, formulate new ideas, and develop a more complete understanding of the factors affecting extinction.

You will share the results of your work with each team's work in a class discussion session. Data could be recorded by each group on an overhead.



Integrated Activity Idea

Obtain and view the video "A River Runs Through It" and then discuss the important issues it raises as a class.

Materials Needed

SimEarth software

Macintosh Plus or later model Macintosh (Also available for IBM)

Users Manual for SimEarth and the Quick Start Guide

(The black-and-white version of the software requires 1 MB of RAM, while 2 MB of Ram is required for color but a hard drive is recommended. System version 6.0.2 or higher is required. Only the black-and-white version of the software has a printing function, so make sure not to lose that version even if you have a color monitor. If you are using a monitor screen larger than 13 inches and are running the color version, you may have to set your partition higher than the default setting of 850K. Page 2 of the System Information and Quick Start Guide tells you how.)

Activity 1 Worksheet



Integrated Activity Idea

Do a report on the social effects of one of the world's major environmental disasters that was caused by technology (Prince William Sound oil spill in Alaska, Three Mile Island nuclear plant emergency, gas poisoning in India, etc.). How could it have been prevented? Was the problem with facility technology or was it human error? Could the damage be reversed with more technology? What were the enduring social consequences?

Manipulating Variables

Establish a control model on the SimEarth program and investigate how it works. Experiment! Using the four control panels, explore the effects of the many changes you can make. On the sheet below, for each control panel, record what happened when you changed one of the variables.

Geosphere Control Panel

Variable: _____

Anticipated Outcome: _____

Simulation Outcome: _____

Comments: _____

Atmosphere Control Panel

Variable: _____

Anticipated Outcome: _____

Simulation Outcome: _____

Comments _____



Biosphere Control Panel

Variable: _____

Anticipated Outcome: _____

Simulation Outcome: _____

Comments: _____

Civilization Control Panel

Variable: _____

Anticipated Outcome: _____

Simulation Outcome: _____

Comments: _____



Integrated Activity Idea

Develop a historical study which focuses on how a selected technology has changed the social fabric of a nation, region or community. Discuss whether the effects were positive or negative. Build a solid rationale supporting your position.

Activity 2

SimEarth Challenge II



Integrated Activity Idea

Report: Have student research teams investigate the controversies surrounding the issue of global warming. Each team is responsible for gathering three or four newspaper or magazine articles on the issue, including at least one that is somewhat skeptical about whether or not global warming is in fact taking place. You should make sure to include any information on the role played by carbon dioxide and on what measures countries and international organizations are taking to control emissions of "greenhouse gases." Each team will then present an oral report, or a dramatization, communicating what they have learned. If some positions emerge that are contradictory to each other, you may want to conduct further research and schedule a debate.

Introduction

Now that you have developed a general understanding of possible factors affecting extinction, you are asked to look at one particular factor in more depth, specifically carbon dioxide.

Procedure

In this activity you will be using the SimEarth program to investigate the impact of carbon dioxide on temperature. Working in teams, establish a control model of the SimEarth program, as you did in the first activity.

Teams will run several tests with selected variables, first increasing and then decreasing them. (Remember to return to the baseline before each new test.) Begin with the Geosphere variable of volcanic eruptions and core heat, then adjust the Atmospheric variables of air-sea thermal transfer and the greenhouse effect, and finally, select the Biosphere control panel to adjust carbon dioxide absorption. Record your data on Worksheet Two, Carbon Dioxide and Atmospheric Temperature.

You will be provided ample time and opportunity to use the computer simulation to test your hypotheses, formulate new ones, and develop more complete understandings of the effect of carbon dioxide on temperature. A class discussion of the research groups' results will follow the completion of the project. This discussion can then lead to additional discussions of social and ethical concerns relating to the environment, including choices in energy use, restrictions on emissions of carbon dioxide, and industry's use of chlorofluorocarbon-producing materials, as well as issues related to recycling and reuse of materials.

Materials Needed

SimEarth software
Macintosh Plus or later model Macintosh
Users Manual for SimEarth and the Quick Start Guide



Activity 2 Worksheet

Carbon Dioxide and Atmospheric Temperature

Using the SimEarth program, investigate the impact of carbon dioxide on temperature by selecting variables, increasing them, and decreasing them. Before each change in a variable, make predictions about what you think might happen.

Geosphere: Volcanic eruption and core heat

Increased result: _____

Decreased result: _____

Comments: _____

Atmosphere: Air and sea thermal transfer

Increased result: _____

Decreased result: _____

Comments _____



Integrated Activity Idea

Project: Have student research teams plan and participate in an interactive mock "United Nations meeting" to demonstrate international debate and concern. Student teams, representing various interest groups, develop and attempt to have ratified a proposal regarding global climate change. Videotape the proceedings. Invitations should be extended to local environmental groups to participate in the debate.

Biosphere: carbon dioxide absorption

Increased result: _____

Decreased result: _____

Comments: _____

Does carbon dioxide influence temperature? In what way? What are your ideas about how and why it has this effect? _____



Activity 3

Landfills

Landfills are our most common method for disposing of waste. However, there are many problems associated with their use. Landfills are difficult to find sites for due to the "not in my backyard" syndrome. Also, the cost of conveniently located land is very high. Landfills must be monitored for many years after closure for leakage into the ground water. This is an expensive maintenance requirement.

Current landfill design actually inhibits the natural degradation of biodegradables due to construction requirements, which route rainfall away from the fill and inhibit oxygen input. Additionally, the diverse mixture of contents often causes degradables to be contaminated with products which are toxic or inhibiting to beneficial bacterial decomposers. Studies have shown that carrots which have been in landfills for over ten years are still recognizable; newspapers have been preserved for even longer.

Garden shops, landscape companies and farmers can profit from recent laws which aim to eliminate yard waste dumping in landfills. Nationwide, yard wastes make up about 20 percent of the residential waste stream. Yard wastes in the United States work out to about 230 pounds per person per year. Food wastes add another 100 pounds per person per year. In landfills, yard wastes can result in methane gas production, acidic liquid drainage from the landfills plus other problems. The sad thing is that this could easily be prevented. These types of waste could actually be of tremendous value if they were properly composted and returned to the environment.

An alternative method of waste disposal is composting. Composting transforms organic waste into a soil-like material that when mixed with the earth can enrich the soil. A wide variety of organic waste, in addition to yard waste, can be composted. This organic waste can come from both on and off the farm.

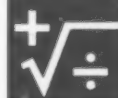
On-farm composting can benefit your farm and also help solve an environmental problem. Composting can be a simple and inexpensive operation or it can be a complex, and expensive business to start. Composting facilities and equipment can vary from essentially nothing to those that are big, specialized and expensive.

1. What are some of the disadvantages to the use of landfills for waste disposal?
2. What are some common terms associated with landfills? Be able to draw a schematic of a modern sanitary landfill.



Integrated Activity Idea

Discuss the possible effects of eventual fossil fuel depletion. When will it happen? What will it cause in terms of economic and political pressures, new sources and types of energy, environmental effects, etc. Overall, will the effects be positive or negative? This would make an excellent total class group project.



Integrated Activity Idea

List solid waste items which are or are not biodegradable. Make charts which contrast degradation rates in a sanitary landfill with "natural" decomposition rate.

Procedure



Integrated Activity Idea

One study which examined "old trash" at a sanitary landfill is entitled "Rubbish!", By William L. Rathje, The Atlantic Monthly, December 1989, pp. 99-109. Obtain and write a report based on this and other related material.

1. To construct a miniature landfill, place 1/3 of the soil in the bottom of the container.
 2. Cover the soil with the plastic, folding up the edges a few inches all around.
 3. On top of the soil place the pieces of trash, plastic, cloth, and foil.
 4. Alternate more soil with the landfill items.
 5. Put the container in a warm place, and keep the soil damp.
- Instructor's Initials**
6. On a weekly basis, check on the condition of the items. Does the fruit or vegetable look different than it did when you buried it? Does the plastic look different? Some things persist for a long time. Which items do you think are more harmful to the environment? Why?
 7. When you disassemble the landfill, look for leakage.

Materials Needed

Litter items or pieces of fruit or vegetables

A small piece of plastic, such as a plastic fork, part of a broken toy, or polystyrene foam

Pieces of paper, cloth, and aluminum foil

A large container, such as a glass jar, or terrarium

Soil

A large piece of immersible plastic



Activity 4

Composting "Enviro-Mints"

Introduction

Compost is typically made from readily-available yard and kitchen wastes. On an individual family basis, composting can save on yard maintenance costs as well as provide savings in taxes and trash pickup costs. Americans landfill about 24 million tons of grass clippings and leaves annually. The end product of composting is a very rich topsoil-like substance, rich in minerals and organic matter. Natural fertilizers and other soil enhancers can be "manufactured" on the spot.

Compostables generally are non-animal source yard and kitchen wastes. The essential components of a successful compost pile are: air supply, sufficient moisture, and a mixture of yard and kitchen wastes that provide the nutrients needed by the beneficial bacteria.

There are four basic composting methods:

- holding units
- turning units
- heaps
- large-scale composting.

Holding Units-The Slow Method

Holding units are containers or bins that hold yard waste and other organic material until composting is complete. Wastes should be added to the holding unit as they are generated. Turning is not required.

Using a holding unit is the easiest but slowest way to compost. Non-woody materials, such as grass clippings, crop wastes, garden weeds and leaves, will turn to compost in holding units, but decomposition can take from six months to two years. You can speed up the process by chopping or shredding wastes, mixing high-nitrogen and high-carbon materials, maintaining proper moisture or turning the pile.

Composting kitchen wastes in a holding unit will require additional management to avoid pest problems. Kitchen waste should be turned into the pile as they are added, and pest-proof sides and a cover may be needed.

Holding units are often made of light materials so that they can be taken apart easily and moved. Possible materials include circles of wire fencing or hardware cloth, old wooden pallets wired or tied together, snow fencing or wire framed in wood.



Integrated Activity Idea

Conduct soil samples on a variety of soils. Compare the soils which contain composted materials with those which do not. Develop a report which is illustrated with graphs and charts.



Integrated Activity Idea

Conduct water sample tests of water from various sites to determine quality. Include sites which could be expected to be affected by environmental pollution (animal, industrial, human, etc.).

Permanent holding units can be made by stacking landscape timbers or concrete blocks, or mortaring bricks or rocks together. The unit should be constructed to allow air transfer through the sides and back. It is helpful to have two or three of these units, one for fresh wastes, another for maturing compost and a third for finished compost.

Turning Units - The Fast Method

Turning units can compost non-woody yard wastes and kitchen wastes in two months or less. Wastes in turning units must be mixed on a regular basis. Frequent turning speeds composting by providing aerobic bacteria with the oxygen they need to break down materials. The compost is turned by moving the materials from bin to bin or by turning them in a rotating barrel or holder.

Turning also produces temperatures of 90-140 degrees which will kill major disease organisms and fly larvae, help kill weed seeds, and provide the environment necessary for the most efficient decomposer organisms.

Heaps

Heap composting is similar to turning-unit and hold-unit composting except that it does not require a structure. The heap should measure about five feet wide and three feet high. The length varies depending on the amount of materials used. Waste can be added as it becomes available, or stockpiled until enough is available to make a good sized heap. It is best to have at least two heaps. When the first one is large enough, it should be allowed to decompose undisturbed.

The pile can be turned regularly, but turning is not necessary. If the pile will not be turned, adding vegetative waste may attract pests. Covering the heap with a layer of yard waste, mulch or soil helps prevent moisture loss and may reduce pest problems.



Technology Idea

Obtain information from the Walt Disney Company regarding the large scale waste and water recycling system which is used at Florida's Walt Disney World complex. Report the results including an assessment of the positive and negative impacts of the system on the surrounding environment.

Large Scale Composting

Farmers can operate large scale composting facilities on their farms. These facilities make money by charging a tipping fee for the compostable materials received and by selling the resulting compost. Or, farmers can reduce their fertilizer costs by using the compost on their own farms.

The size and type of equipment needed depends on the scale of the operation. For a passive pile approach, labor and equipment used to form and mix initial piles are the largest operational expense. Loaders and manure spreaders are used to perform these jobs. Pile formation costs can range from less than \$1 per ton to more than \$6 per ton of incoming material. The costs vary with the materials composted and the amount and kind of equipment used.

Windrow composting also uses a loader for turning and is similar to passive pile composting because the only equipment needed is a tractor, loader and manure spreader. The key difference is that the piles are actively managed and turned. Volumes of material are likely to range from a few hundred to several thousand cubic yards per year.



Municipal leaf compost operations report that it costs about \$5 per ton of raw material to turn piles with a front end loader three to four times per year. This cost includes equipment, land and labor. The turning and formation is around \$4 per ton of raw material. Land and labor adds another \$1 per ton to the cost.

Procedure

Creating a composting structure is very simple. An ideal size is 4' x 4' x 4'. Approximately one cubic yard of compost is needed to generate decomposition temperatures (104-170 degrees). Since air helps the bacteria decompose waste, a tightly-packed pile is to be avoided. Open wall supports, such as chicken wire or fencing facilitates air exchange.

Readily compostable wastes include all yard wastes (i.e., grass clippings, hedge/tree trimmings, weeds) with the exception of thick tree branches and trunks, and all food wastes with the exception of animal products (although egg shells are fine to include). It is best to exclude animal products, including bones, grease, meat wastes, manure, and dairy products, to avoid problems with vermin such as rats and mice. A "vegetarian" compost heap is very trouble-free.

A viable compost pile is started by mixing equal parts yard and kitchen wastes. Yard waste only is poor in phosphorus, potassium, and trace minerals, while kitchen waste alone is poor in nitrogen.

1. Layer the base with yard waste e.g., thin sticks, leaves, and grass clippings.
2. Sprinkle with a thin layer of dirt to introduce the bacterial "workers" and add kitchen wastes, such as vegetable and fruit parings. Rotten produce is fine to add as well, since it is already beginning to decompose and has been inoculated with "willing workers."
3. Cover this food waste layer with a few more leaves and clippings, and lightly sprinkle with water. Heaps should be kept lightly moistened, not saturated, in order to keep the bacteria slightly wet, but not separated from the air supply.
4. Continue layering as wastes are generated, and occasionally turn the whole pile to better aerate the heap and to see the production of the top soil. Any part of the pile which is black, friable, and smells like soil is immediately usable as a soil additive. If the heap begins to smell rank, it is likely due to excess moisture and should be dried out by spreading the pile out in the sun for a few days or by turning it.

To avoid air flow problems due to compaction, the pile should not exceed 4' in height. However, due to the ongoing decomposition, the pile will always be shrinking, so that the maximum height actually takes quite a while to achieve. Specific steps should include the following:



Integrated Activity Idea

Interview your local watershed representative. When is the landfill serving your community projected to be filled at current disposal rates? How old will you be?



Integrated Activity Idea

Call the local sanitary engineers. Find out how many truckloads of solid waste are emptied at the landfill every day, and how much weight/volume each truck holds. Ask if any solid waste is incinerated or otherwise disposed of in lieu of the landfill.

- Construct a small compost pile in a terrarium or old aquarium.
- Layer the pile as listed below in materials list, adding the fertilizer to the layers of waste.
- Turn the pile weekly, taking the opportunity to remove certain waste items and note their state of decomposition.
- Place removed waste items in small baggies (freeze, if possible and compare the items over many weeks or months.)
- Record what you smell and see when working with the compost pile.
- Record temperatures on the bottom, middle and top of the pile. Where is the pile warmest? Coolest? Why?

Materials Needed

Terrarium or old aquarium

Organic waste materials: sawdust, hair, wood, food scraps, leaves, grass and ashes. Do not use meat, fat, oils, or manure.

Lawn fertilizer containing nitrogen, but not herbicides or insecticide. A ratio of 25-30 parts carbon to 1 part nitrogen is ideal (this addition will speed up the process);

Soil

1-2 dozen earthworms (also will speed up the process); Using earthworms will also help to wrap the exterior of the composer with brown paper to inhibit the entrance of light.

Small spade or large spoon for turning and aerating the pile.



Activity 5

TerrAqua Column

Introduction

Water, as it cycles between land, ocean and atmosphere, is essential to their survival of virtually all living things. Water drips off rooftops, flows over roads, off your toothbrush and down the drain, percolates through the soils of fields and forests and eventually finds its way into rivers, lakes and oceans. During its journey, water picks up leaf litter, soil, nutrients, agricultural chemicals, road salts and gasoline from cars, all of which have profound impacts on life in aquatic and terrestrial systems. Water can also be filtered or purified as it percolates through soil.

The TerrAqua Column (TAC) provides you with a model to explore the link between land and water. You can use TerrAqua columns to study how chemicals put on the land affect the water, whether different commercial fertilizers affect the ecosystem in the same way, and whether salt entering the water system (as is happening with the ground water in Florida) can affect land plants.

TerrAqua columns have three basic components: soil, water and plants. On top is an earth based ecosystem of grass (using ordinary lawn seed) growing in soil.

Underneath is an aquatic ecosystem, including water plants available from pet stores or duckweed and other aquatic life forms found in lake water. (During winter, check around the edges of lakes where thermal pollution keeps the water open.)

The systems are connected when water drips from the land system to the water and when water follows a wick up into the soil. A cotton cord or Pellon, an interfacing fabric available at sewing stores, works well as a wicks. Be sure to wash Pellon with warm water to get rid of flame retardant chemicals that are poisonous to plants.

Plants growing in the upper part of the TAC absorb nutrients from the surrounding soil and, with the aid of the wick, take water and other substances from the aquatic portion below. Substances you add to the terrestrial section will move down, or percolate, through the soil and drain into the aquatic section.

How do land and water interact in your area? Does runoff from fertilized lawns or agriculture threaten the quality of your streams or ground water? Is salt pollution a problem, from either road salt, irrigation, or saltwater intrusion? Are landfills affecting local ground water?



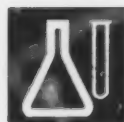
Integrated Activity Idea

Identify a waste related disease problem from history. What was the specific nature of the cause of the disease? How could it have been avoided even without modern medicines simply through better waste and health management procedures?

Procedure

Soil, Water and Plants

Fill the top unit of your TerraAqua Column (TAC) with soil you collect, or with potting soil from a gardening store. Fill the lower aquatic unit with tap water, or water from a pond, lake puddle or fish tank. Collected soil and water will likely contain algae, phytoplankton, plant seeds and insect larvae. Store-bought soil and tap water will include far fewer organisms. (To observe this, fill one TAC with soil and water from nearby woods or park and another with potting soil from a garden store and tap water.) Set them side by side and observe for several weeks.



Integrated Activity Idea

Take a field trip to your local sewage and water treatment plant. Have a scientist describe how the treatment process works. Then prepare a set of diagrams which illustrate the process. Examine or propose alternative methods which could also be used.

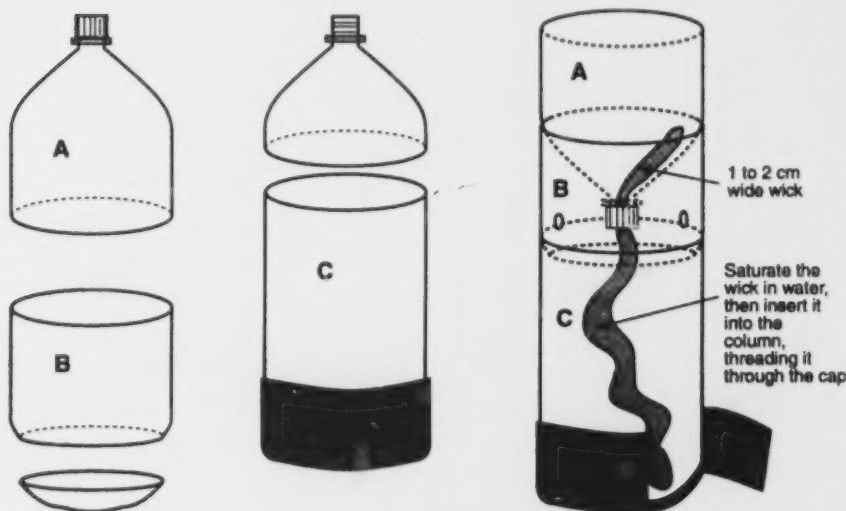


Figure 1 - Bottle TAC

Terrestrial and aquatic plants are excellent indicators of change in your system. Fast, germinating and fast-growing plants will most effectively register change in a short period of time. Grasses, particularly lawn seed mixes, work well. Prairie grasses grow more slowly but have deep roots that are interesting to observe. Radishes and beans also work well.

The TAC allows you to examine the effects of specific variables on your mini-ecosystem. For example, you could build several TACs in order to explore specific factors that might encourage algae. Try taking samples of lake water and local soil, for example, and then testing them under different conditions to see in what sorts of environments algae grows best.

Your observations and experiments can go in many directions, so the clearer you are in defining your question and designing your experiment, the more



successful your experiment will be. The following factors are important to keep in mind as you conduct your experiments.

- **Variables:** Variables to consider in your research include: The type and amounts of soil, water and plants. Remember, depending on their source, the soil and water will likely contain such life as algae, fungus, mites, daphnia, etc.
- **Substances** that might affect terrestrial and aquatic systems nutrients (fertilizers), or pollutants (salts, pesticides, acids). Once you have decided on a substance to test you can apply different amounts of that substance; treat only the terrestrial chamber; treat only the water reservoir; apply it directly to plant leaves; test it on plants of various ages, or vary the treatment schedule.
- **Physical factors** include temperature, light, sound, etc. (try singing or screaming at your plants.)
- **Indicators** in a TAC are plants and animals and other system characteristics that change in response to your experiments, giving you information regarding your hypothesis. Indicators include terrestrial and aquatic plants and the pH of soil and water.

Some observations you can make of a plant indicator, for example, include percentage of seeds that germinate, plant height and weight, leaf size and shape, root structure, number of flowers, length of life cycle and seed production. In the aquatic system, indicators include increases or decreases in populations of algae and duckweed. These changes can show up as cloudiness in the water.

- **Controls:** With every experiment you run, set up one control TAC in which you do not vary any of the components. This acts as a standard against which you can compare the effects of variables you do change.

The TAC is a simple model, but all of its parts are dynamic. Keep your investigations very simple by changing only one variable of the system at a time. Some commonly investigated substances include fertilizer, pesticides, acid rain, and oil. A detailed example of a salt solution experiment follows; you can also use the procedure to investigate other substances.

Experiment 1

In this experiment you will test the effects of salt carried by water runoff from streets on plant life and aquatic systems.

1. Plant seeds in 4 TACs.
2. After plants have sprouted, label one column CONTROL, label a second 0.1% NaCl, a third 1.0% NaCl and the last TAC 5.0% NaCl.
3. Prepare salt solutions of 0.1%, 1.0% and 5.0% salt by weight. (For example, 0.1% is one tenth of a gram per 100 ml of water or 1 gram per liter of water.)

4. Treat each TAC with 10 ml of the appropriate salt solution. Use an eye dropper to place 5 ml on the soil and 5 ml in the reservoir. Treat the CONTROL with plain water.
5. Treat plants every seventh day.
6. Observe and record plant development, including height, leaf number, size and color. You might also take pictures of the plants to monitor changes in color and other aspects of physical appearance.
7. Test the soil pH.
8. Repeat this experiment, or run several at once. Can you reproduce your results?

Experiment 2

Repeat the procedure for experiment 1 with different concentrations of fertilizer solutions. How does fertilizer carried by water runoff from fields and lawns affect aquatic plants and animals?

If you would like information on building bottle biology experiments, write to the Bottle Biology Program, Dept. of Plant Pathology, 1630 Linden Drive, University of Wisconsin-Madison, Madison, WI, 53706.

Materials Needed

2 - 2 liter plastic soda bottles
 Scissors or utility knife
 Soil
 Water (tap, lake, etc.)
 Plants
 Salt
 Fertilizer



Assessment

Scoring Rubric for Activity 2 - SimEarth Challenge I

Performance Standards	Wgt. %	Exemplary 2 pts.	Acceptable 1 pt.	Not Yet Acceptable 0 pts.	Sub total
I. Creative Thinker					
Analyze a technological activity and describe the four potential environmental impact outputs: Type I: expected desired outputs; Type II: expected undesired outputs; Type III: unexpected desired outputs; and Type IV: unexpected undesired outputs.	x1	Student correctly describes all four impact outputs for one of the control panels of SimEarth.	Student correctly describes 2 potential outputs for one of the control panels of SimEarth.	Student correctly describes 1 potential output for one of the control panels of SimEarth.	2 x 1 = 2
II. Critical Thinker					
Comprehend that technology creates solutions to problems as well as creating additional problems.	x2	Student correctly documented and compared the anticipated/simulated outcomes of all 4 panels.	Student correctly documented and compared the anticipated/simulated outcomes of 2 panels.	Student correctly documented and compared the anticipated/simulated outcomes of less than 2 panels.	2 x 2 = 4
Debate the positive and negative impacts of technology on social values, the government, and individual quality of life.	x2	Student effectively debates the impacts of technology on two different issues using SimEarth.	Student effectively debates the impacts of technology on one issue using SimEarth.	Student does not effectively debate the impacts of technology on any issues using SimEarth.	2 x 2 = 4
III. Contributing Citizen					
Discuss, develop, and practice a home, school, or community recycling program per local guidelines.	x1	Student correctly discusses, develops, and practices a recycling program per local standards (from activity 4).	Student correctly discusses and develops a recycling program per local standards (from activity 4).	Student correctly discusses a recycling program per local standards (from activity 4).	2 x 1 = 2
Discuss the ways in which social and cultural values have influenced the technologies which have been chosen for development.	x5	Student group documents and discusses 3 different values they used to make technological decisions under the civilization panel.	Student group documents and discusses 1 value they used to make technological decisions under the civilization panel.	Student group does not document and discuss any values they used to make technological decisions under the civilization panel.	2 x 5 = 1
IV. Self-Directed Learner					
Identify various career options in environmental-related areas.	x5	Student correctly identifies and reports 3 different career options.	Student correctly identifies and reports 1 career option.	Student does not correctly identify and report any career options.	2 x 5 = 1
V. Problem Solver					
Comprehend the Waste Stream and society's ways of addressing this problem: Landfill, incineration, recycling, and other alternatives.	x5	Student writes a technical memo addressing 3 ways society deals with the waste stream.	Student writes a technical memo addressing 1 way society deals with the waste stream.	Student does not write a technical memo or correctly address how society deals with the waste stream.	2 x 5 = 1
VI. Effective Communicator					
Discuss and illustrate ways in which technology reflects the values of society (e.g., freedom and the automobile).	x5	Student illustrates how differing civilizations fared by choosing different technologies (3 examples).	Student illustrates how differing civilizations fared by choosing different technologies (1 example).	Student does not illustrate how differing civilizations fared by choosing different technologies.	2 x 5 = 1
VII. Quality Producer					
Research government agencies and regulations that deal with environmental impacts that are tied to technology.	x1	Student identifies 3 government sources and analyzes their regulations on environmental impacts of technology.	Student identifies 1 government source and analyzes their regulations on environmental impacts of technology.	Student does not correctly identify any government sources or fails to tie the source to environmental impacts of technology.	2 x 1 = 2
VIII. Technical Foundations					
Comprehend and discuss the three major technological ages (Agriculture, Industrial, and Informational) of society and assess technology's role in these eras.	x1	Student correctly identifies 5 major technological accomplishments per each age on a written exam.	Student correctly identifies 3 major technological accomplishments per each age on a written exam.	Student identifies <3 major technological accomplishments per each age on a written exam.	2 x 1 = 2

Total: 20 out of 20 possible

The Ecosphere: Where all Life Exists

Test

True or False:

- _____ 1. Most of the radiant energy striking the earth from the sun is converted into sugars by plants during photosynthesis.
- _____ 2. Animals could not live without plants.
- _____ 3. The presence of life has actually changed the non living parts of the Ecosphere.
- _____ 4. Plants could not live without animals.

Give brief answers to the following on the back of this sheet:

5. What kind of problems might exist in predicting the "Greenhouse Effect" by computer? _____

6. Name three non-living ingredients involved in photosynthesis. _____

7. Name three things produced as a result of animal and plant respiration.

8. Name five major terrestrial ecosystems. _____

9. What organisms are involved in the critical nitrogen fixation step of the nitrogen cycle? _____

10. What gas is believed to be the most critical in producing the "Greenhouse Effect"? _____

11. What is meant by succession? _____

12. How does early plant life create soil? _____



Impacts and Values TechFolio

Make a Technology Impacts and Values TechFolio which could include the following items:

- Reflective response paper based on viewing of the "Electric Horseman" video.
- An energy audit of the school or your home (see TAM 13 - Energy & Power Guide for more information).
- Technical report detailing scenario outcomes as projected in the Sim Earth challenges.
- A report on global warming and the greenhouse effect.
- Activity worksheets from this TAM.
- Technical writeup of landfill/composting test (activity 3).
- Photographs of "ugly scenes" in your town.
- Listing of environmental noise hazards in your community.
- Other

Note: Refer to page 82 in the Performance Standards Education Implementation Handbook for information about how a TechFolio could be scored.

By Steve McNaught



Instructor Resource

The Big Picture!

Content Outline

1. Environmental Systems

- Biological
- Human
- Ecological

2. Recycling Technologies

- Natural
- Chemical

3. Hazardous Waste Disposal

- Nuclear Waste
- Non-biodegradable materials
- Industrial Pollutions

4. Environmental Problems

- Global Warming
- Ozone Depletion
- Fossil Fuel Use
- Deforestation
- Industrial Pollution
- Overpopulation

5. Technology as Potential Solution

Instructional Resources

Books

McCroy, T. Understanding and Using Technology Todd Davis Publications, Inc.
Bottle Biology Kendall/Hunt Publishing Co.

Miller, G. Tyler, Jr. Living with the Environment. 8th Edition; Wadsworth
 Publishing Co., Belmont California.

1992 Macintosh Secondary Science Curriculum Handbook, Apple Computer
 Inc., Cupertino, California

Videos/Slides/Films

The Ecosphere: Where All Life Exists and Spaceship Earth; Available from
 United Learning, 6633 West Howard Street, Niles, Illinois 60714

The Electric Horseman - commercial video

A River Runs Through It - commercial video

Magazines

Discover; P.O. Box 420087, Palm Coast, Florida 32142

Software

SimEarth, The Living Planet is produced by Broderbund Software. SimEarth is a planet simulator, based on the Gaia theory of James Lovelock and others in which the Earth is seen as a living and complex organism, a dynamic system in which changes in one aspect, even seemingly small changes, may have major ramifications throughout the entire organism.

Installation on a hard drive requires only that the program be dragged into a new folder on the disk (Macintosh Version). Data is read as a visual representation from several types of graphs. A map of the planet being created and evolved appears on the screen, which graphically shows new elements as they are added. Evolutionary milestones appear on the screen as conditions are created for the existence: "Reptiles have evolved."

Planets can be started for four different time scales, can be saved or continued, and their visual representation and vital statistics printed. The number of different models for various factors is staggering. There is a great deal of concise and relevant scientific information in the User's Manual.



Equipment Requirements

Two to three students per computer is the maximum for hands-on experience. (With limited equipment, assign concurrent activities to achieve this ratio.) It is best if the students can work together in groups of two or three students each.

This software requires a Macintosh Plus or later model Macintosh. The black-and-white version of the software requires 1 MB of RAM, while 2 MB and a hard drive is recommended. System version 6.0.2 or higher is required. Only the black-and-white version of the software has a printing function, so make sure not to lose that version even if you have a color monitor. If you are using a monitor larger than 13 inches and are running the color version, you may have to set your partition higher than the default setting of 850K. Page 2 of the System Information and Quick Start Guide tells you how.

This Software is also available for DOS Compatible machines.

Glossary of Terms

Atmosphere - The layer of gases surrounding the earth. One of the three major physical divisions of the Ecosphere.

Climax Community - The final stage in ecological succession resulting in a community of organisms which remains stable for a long period of time.

Combustion - The non-biological decomposition of carbon containing fuels, usually accomplished by burning, that releases energy, carbon dioxide, and water.

Ecological Succession - The natural, sequential replacement of one biological community by another.

Ecology - The study of the relationships of living organisms between each other and their physical environment.

Ecosphere - The global ecosystem created by the interaction and exchange of materials between the living and non living parts of the world.

Ecosystem - A specific area, such as a forest or estuary, that includes living organisms acting to produce an exchange between the living and non living parts of that system.

Eutrophication - The natural aging of lakes and ponds which is accelerated by excess nitrogen compounds in the water.

Food Chain - The sequence of transferring energy in the form of food from one organism to another.

Food Web - A complex interlocking series of food chains.

Greenhouse Effect - Trapping of solar heat energy by the earth's atmosphere.

Hydrosphere - The surface water on earth. One of the three major physical divisions of the Ecosphere.

Legume - A large group of plants characterized by true pods enclosing seeds whose roots are home to bacteria capable of converting atmospheric-free nitrogen into a fixed or chemically combined form. Because legumes are rich in nitrates, they are often even plowed under to enrich soil. Examples include peas, alfalfa, and clover. Palo Verde trees.

Lichen - An organism that is part alga and part fungus living as a single unit.

Lithosphere - The solid portion of the earth's crust. One of the three major physical divisions of the Ecosphere.

Metabolism - All of the chemical reactions that take place in an organism as food is utilized.

Nitrogen Cycle - Circulation of nitrogen among the atmosphere, soil, consumer, plants and animals of the earth.

Ozone - A highly reactive molecule composed of three oxygen atoms. High in the atmosphere it forms a layer that filters out harmful ultraviolet light. Near the earth's surface it is a damaging component of smog.

Photosynthesis - The process by which plants convert the sun's energy into the chemical bonds of carbohydrates as a result of chemically combining carbon dioxide and water.

Respiration - The oxidation of food by organisms that release energy, carbon dioxide, and water. Also refers loosely to breathing.

Ultraviolet radiation - Electromagnetic energy, usually from the sun, whose wavelengths are slightly shorter than those of visible light and which can be harmful to living things.

Safety Factors

Any and all safety rules related to computers and their operation, as well as equipment used in reporting and presenting their findings in their group discussions and class presentations. General safety rules used in the construction of the other projects should be emphasized.

Care should be exercised when handling decomposed and decomposing materials. Wash hands thoroughly and treat any cuts or open sores using appropriate medical procedures.

Instructional Suggestions

- Adapt the activity for your students, your curricular emphases, equipment availability, and schedule. Because the possible range of content in this unit is so vast, you may want to devise a more limited approach, such as concentrating solely on dinosaur extinction or perhaps emphasizing the second part of the unit concerning carbon dioxide. On the other hand, you could plan a series of related activities to extend throughout an entire semester.
- Duplicate activity worksheets.
- Have available some books, magazine articles, video programs, or other general background on environmental issues.

Motivation

In these activities, students create and manipulate simulations while making observations and hypotheses about the effects of changing factors on geologic and biological development. In doing so, they deepen their understanding of the following:

- The geological and environmental conditions of a planet must satisfy certain conditions in order for subsequent developments, including the growth of life-forms, to take place. These conditions and the forces and circumstances responsible for their development are interrelated and can be seen as a complex and dynamic system.
- Fossil records document extinction of life forms. Extinction is a natural part of biological development that has impacted evolution. Explanations of extinction need to take into account both the species that become extinct and those that survive.
- We humans have had and continue to have a profound impact on the Earth. People can choose to change their behavior in order to avoid impacting the environment in negative ways. We share a social responsibility to protect the natural resources of our planet.



Prerequisite Information

- Ability to read maps and interpret graphs.
- Familiarity with the process of controlling variables in scientific experimentation.
- Some general background in concepts of earth, and environmental science, geology.
- Identify human behavior as it affects the environment, and apply information to the real world.

On the Computer:

- Use the basic computer interface of choice.

Demonstrations

If students do not have a basic knowledge of the computer interface they will be using, you may want to demonstrate it to them, but I am basing this activity on the fact that the students do have a basic understanding of the computer and knowledge of its operation.

At some point during your discussions, you may also want to point out that all models and simulations have their definite limitations. As the documentation states, "Anything as complicated as the Earth or an animal or even a Ecosphere cannot be completely defined by formulas and equations. Any model of something that is this complicated cannot be completely accurate - but if you are aware of the inaccuracies, the model can still be useful." In other words, your students should understand that the simulation on the SimEarth program is dependent upon the data that the program was built upon. It is based on selected input and cannot be a complete representation of reality. If you were creating a software program like this, is there something else you would add? What would you change? After your students have become familiar with SimEarth, and based on additional research about evolution and extinction, a discussion of the possible biases and other limitations of the model would raise many issues and provide a revealing way to assess growth in independent thinking.

Academic Enrichment

Refer to the spin-off activities written in the student component of this TAM. There are many activities which students of all levels can find intriguing and accomplishable.

Related TAMS

- Introduction to Energy & Power Technology Guide
 - TAM 1 Energy & Power Odyssey - Applications for the Future
- 1990 Implementation Workshop TAMS
 - TAM 16 Recycling Materials in Industrial Technology
 - TAM 19 BioTech: A Materials and Processes Approach
 - TAM 20 The Human Engine
- Performance Standards Project
 - TAM 5 Bio-related Technology

Assessment/Evaluation Suggestions

- Many levels of assessment can take place during the course of this activity. Students will perform the key tasks of selecting and manipulating variables during their time at the computer.
- Worksheet results and project reports provide opportunities for students to demonstrate their understanding of the importance of manipulating a single variable at a time, first predicting then recording the effects. Predictions may become closer to simulation results as students become familiar with the process, and important reasoning processes and logical thinking skills come into play as students consider the gaps between predictions and outcomes.
- The designing and running of controlled experiments through simulation to test extinction theories demonstrates the full range of scientific abilities.
- Class discussion of the research groups' results provides an excellent opportunity for teacher assessment of student understanding.
- Real-life application of what has been learned becomes a mirror of how and what students understand, as discussions expand to include the current environmental situation.
- You may also want to consider having students make revised time lines based on their new understandings. The general format of these activities also lends itself to portfolio assessment through writing and use of media tools.
- It may be helpful for you to make a check list that includes several learning goals or basic ideas that you would like all students to gain or refine throughout their experience with this activity and this entire unit.
- As students make their presentations, you can use this checklist to indicate whether or not the students are demonstrating a good working knowledge of these main ideas.

Note: Review the assessment items which are presented throughout the Performance Standards TAMS for ideas which can be adapted for this TAM. You should also refer to the Performance Standards Implementation Handbook for additional assessment examples and ideas.

Summary

These activities have been developed to give students an understanding of why the study of technology, the environment, and the impacts that technology has had upon the environment is important. You will examine recent changes in attitudes toward the environment. The activities conduct an investigation into the causes and solutions of environmental problems.

Specific responses will vary because students may choose a variety of ways to record and share their results, and these will need to be evaluated on a case-by-case basis and in relation to the conceptual framework, hypotheses, and experimental model students originate and describe. What is most important is that students demonstrate a grasp of the scientific and technological processes involved and a growth in sophistication and understanding over the course of the entire investigation process.

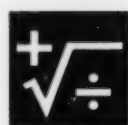
Through discussion on an individual basis and with the class as a whole, you may determine that misconceptions still exist in the minds of the students regarding variables affecting our planet. You may also want to ask students what additional questions and concerns they have, and what further investigations they would be most eager to explore. Their ideas can both reveal the learning that has taken place and help point the way to topics for future activities.



"Minds-On" Making

Goal

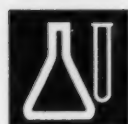
After completing this unit, you will have a greater understanding of how "things" make it into their final form. In addition, the experiences gained should allow you to understand the materials and the processes of a product and how and why the products last (or don't last).



Mathematics



Communications



Science



Social Studies



Fine Arts



Health



Technology

Performance Standards

- Based on current trends, speculate on the types of new materials which could be expected in the future.
- Identify products that have been developed within the past decades using new materials.
- Recognize and analyze the potential and negative impacts of the increased use of materials (renewable, limited, and unlimited resources) on students, their future unemployment, the environment, and society.
- Discuss the relationship between materials harvest, development, and ecology.
- Demonstrate proper care and safe handling of all laboratory tools used in processing materials.
- Discuss the factors affecting material selection including strength, weight, color, texture, etc.
- Describe those practices and terms used in processing, including shaping, forming, combining, and removing.
- Demonstrate the ability to work with highly specialized processing equipment, including those associated with forming, shaping, combining and removing materials.
- Practice all safety procedures when in the lab and when using the tools associated with materials and processes.
- Identify the various foundation skills for different career options in materials and processes.
- Identify typical applications in which materials and processes are effectively used in industry.



Introduction

When you click on the television set, open a compact disc, feed yourself, and brush your teeth, what are you dealing with? Somebody's product. For us to satisfy our daily needs, someone must take materials, study their properties and process them into usable products. Materials come in all forms, natural or synthetic (man made). To select the right material for the right product is the tricky part. Materials are chosen on the basis of their properties. To make wire for your headphones without some sort of **insulator** (plastic) would be disastrous. If you buy a pair of \$100 shoes and the sole unglues from the leather - you might come unglued! There are very few products sold today which have not been processed in some shape or form. An egg has an egg carton, a penny has been stamped, and a credit card has its magnetic strip and holographic seal. The exercises in materials and processes which you are about to undertake are but a fraction of the many activities possible to explore. Make notes of products which you would like to explore in greater detail. Talk to your instructor about possibly using various materials and processes to make that product in your technology education class. Use your imagination. Be an imagineer!

Objective Statement

The activities described in the following pages represent samples of activities which can be used to deliver these performance standards on page 1. Many additional activities can and should be used. Extreme care should be taken to connect each activity with appropriate activity objectives as well as with the performance standards. These objectives should be developed by the instructor and should be shared with and made clear to the students.



Integrated Activity Idea

Have your math class study the length of wood necessary to bend and laminate a $3/32$ " thick strip of wood to make a 6" dia. hoop to fasten to the backboard.



Technology Idea

Investigate possible career opportunities in materials and processing areas. Review the Introduction to Materials and Processing Guide for more information about what kinds of areas are included in materials and processes. Follow this up with a field trip to observe and interview those involved in careers which interest you. After this, explore your interest areas in more depth using the Dictionary of Occupational Titles (D.O.T.). Give special attention to the skills and education required.



Integrated Activity Idea

Have each student present the manufacturing technology in a foreign language.

Activity 1

Backboard & Hoop for Wastepaper Basket

Wood can be very **elastic**, which means that it bends and then returns to its original shape. But, it can be quite brittle depending on the type of wood. In this activity, you will try to change the wood's shape into a new shape, a hoop. If a material can retain its shape after being formed, then it has what is called **plasticity** properties. You'll see how it works soon.

Each student will receive a package of supplies needed to complete a backboard and hoop that will be created in the laboratory. In addition, you will learn more about silk screening and manufacturing process. Follow the plan of procedure closely.

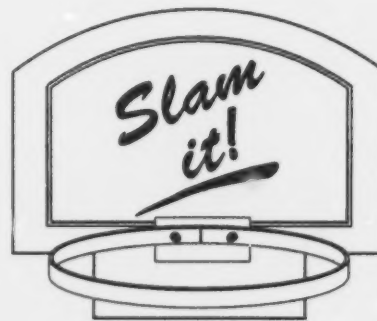


Figure 1 - Slam It Hoop

Cutting the Hoop

1. Rip $3/4$ " pine or basswood into a $3/32$ " x $22\ 1/4$ " strip. Have the instructor check setup and safety before making cuts.

Machining the Hoop

2. Drill $9/64$ " holes $1\ 1/2$ " from each end. Next, drill $1/8$ " holes $1/2$ " from each end. Sand both sides to remove sawmarks. Allow strip to soak overnight in a wallpaper waterbox.



Figure 2 - Hoop Strip



Cutting the Backboard

3. Using a band saw, cut 1/8" hardboard into the shape shown below.

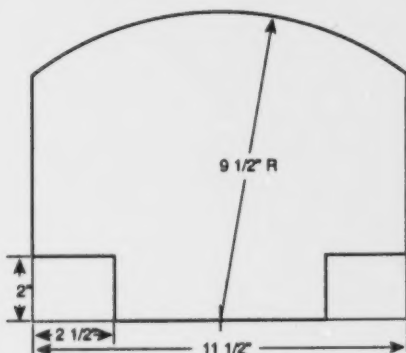


Figure 3 - Backboard Shape

4. Save both for later.

Machining the Backboard

5. Drill 2 9/32" holes into backboard to mount clipboard clip. Ask instructor for clip to ensure proper alignment. **Instructor's Initials**

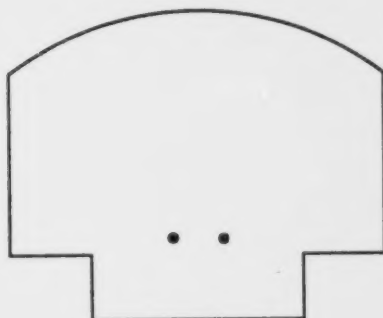
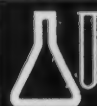


Figure 4 - Clipboard Clip Holes

Silk Screening the Backboard

6. Design a backboard pattern and make a **silkscreen**. (Ask instructor for instructions; one may be prepared for you.) Silkscreen image to backboard and allow it to dry. Add stickers if desired.



Integrated Activity Idea

Ask your science instructor to help you research various chemicals which allow wood to bend easily. Also, explore what is occurring at the cell level to make the wood bendable.



Integrated Activity Idea

Have the class work with the Social Studies teacher on manufacturing materials and processes and how they have affected the nation's economy. Select a single product for study.



Technology Idea

Use "Typestyler," "Printshop," or computerized clip art to enhance your design.



Figure 5 - Silkscreen Image

Wood Bending the Hoop

7. Remove the wood strip from waterbox and fasten one end to the hoop forming jig with a drywall screw and washer in the last hole. Shaping the wood slowly, bend around until a hoop is formed. Fasten opposite end and allow to dry overnight.



Technology Idea

As a class, set the activity up as a mass production. Include a marketing division and market the goals throughout the school. Consult with the marketing or business education teacher for assistance with setting this up.

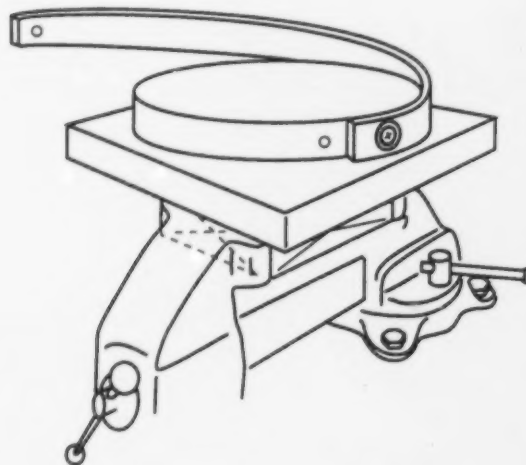


Figure 6 - Hoop Bending Jig

Apply Finish to Hoop

8. When dried, remove hoop and wipe on penetrating oil finish.

Fasten Clip and Hoop to Backboard

9. Fasten clipboard clip to the backside of the backboard with 2 6-32x1 machine screws, washers, and nuts. Your hoop support piece may be



glued between the machine screws with wood glue. Next, dab wood glue to the backside of the hoop where it will strengthen the hoop support. Slide the hoop onto the screws and add nuts. Be careful not to overtighten the nuts; **it may crack the hoop.**

10. Fasten to your wastepaper basket and test away!

Materials Needed

Supplies

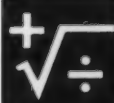
22 1/4" clear pine or basswood
9 1/2" x 11 1/2" hardboard
Clipboard Clip
6-32 x 1 machine screws
6-32 machine nuts
Small washers
3/4" drywall screws

Equipment

Table saw
Band saw
Drill
Finishing sander
Screwdriver
Pliers
Hoop forming jig
Silkscreen and ink

Activity 2

Metal Structures "Boat Dock Designs"



Integrated Activity Idea

Have your Physics teacher give you a formula to calculate how much a piece of styrofoam 1" x 12" x 12" will support in a freshwater lake.

The following activity will acquaint you with the fabrication of metal trusses and their uses. Prefabricating means to build a portion of the construction job at a location other than the construction site. This has been done with many metal and commercial buildings for years. In recent years, the practice of prefabrication has moved into the residential home market.

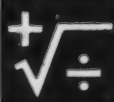
Metal trusses are used instead of floor joists or wooden trusses because they have increased strength. In this application, trusses resist weathering and decay when exposed to water. You will also see the thermal characteristics like conduction of heat in copper. Mechanical properties of a structure (torsion, compression, and toughness) are enhanced when metal trusses are placed in unsteady environments, such as water.

You will work with a partner and be given a supply of materials to construct a model of a boat dock. To ensure a quality model, follow directions closely.

Procedure

Wire Preparation

1. Cut 14-2 WG cable into 3 @ 15' and 2 @ 24' lengths using linesman's pliers. Remove insulation down to the bare wire. This can be done by using a utility knife to cut and peel off the outside insulation. Then clamp one end of a wire in a vise. Working from the last 3 inches, slowly and carefully pull off the insulation with wire strippers or slip joint pliers. Work your way up the wire until all is removed from each piece.



Integrated Activity Idea

Calculate force and pressure of an object (truss). See TAM 15 Bridge Building on how it relates to design.

Fabricating Truss Core

2. Ask your instructor for the truss forming jig (you may need to make the jig if it is not already built). Place two nails into the first two holes on the left. Take one 24' wire and make a 90 degree bend at one tip. Lay the bend around the first nail, then, carefully and tightly, wrap the wire over the nail to make another bend. Add a nail and continue until a 15' truss core is made. The scrap will be cut off later. **Do not remove the nails yet.**

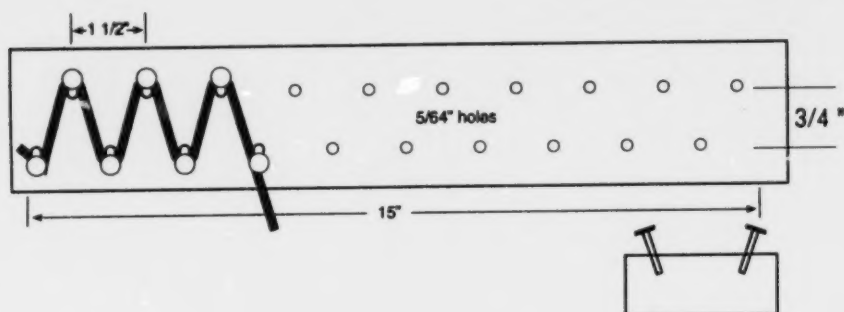


Figure 7 - Truss Forming Jig

Soldering Truss Core Together

Safety glasses must be worn while soldering. It is also essential to have proper ventilation. Remember: soldering irons get very hot and copper conducts heat very easily, so gloves should be worn.

3. Working with a partner, have one person lay a 15" piece against the zigzag part of the truss to form the top plate. Lay the wire against the core, not on top or underneath (see Fig. 8). One person holds the wire with a screwdriver while the other solders. (Be sure to heat **both** wires then slowly add solder, but not to the gun.) Work your way down, then repeat the process on the other side.

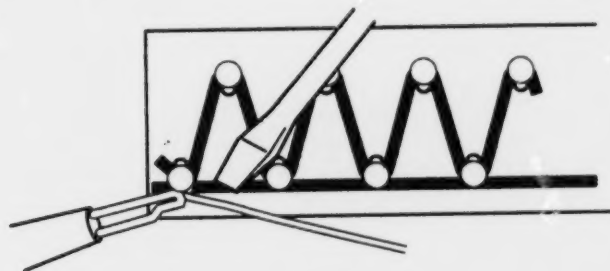


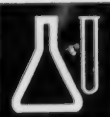
Figure 8 - Soldering Process

Shearing Trusses to Length

4. Remove nails, (remember they are drilled in at an angle) with pliers. This completes one truss. Repeat step 3 to make 4 complete trusses. Shear excess wire with diagonal pliers. **Be extremely careful: Pieces can fly!**

Forming Trusses to Shape

5. Mark two trusses 1 1/2" from each end. With pliers, bend both at 90 degrees up. Instructor's Initials



Integrated Activity Idea

Conduct an environmental study using metal and plastics in water. Present your findings to the class.



Technology Idea

Examine the truss structure in your school building to see how they were built and assembled together

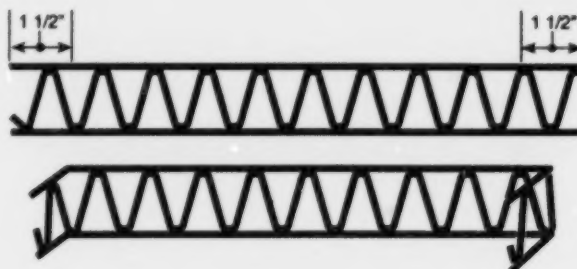


Figure 9 - Bent Truss

6. Mark and cut one truss to 13 1/2", then mark 3/4" and 5 1/2" from each end. Bend the 3/4" marks 90 degrees up and the 5 1/2" marks down 90 degrees.

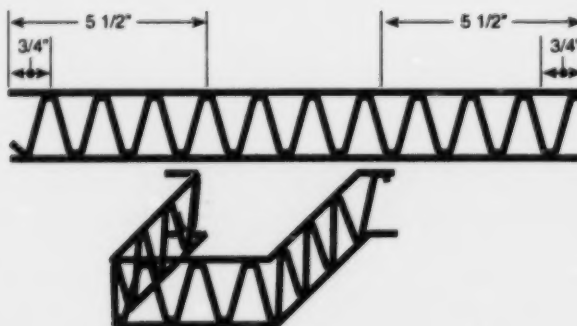


Figure 10 - 2nd Bent Truss



Integrated Activity Idea

Make a video which combines footage of a building being built with a tutorial on how to build trusses.

Forming Truss to Shape

7. Using the last truss, measure and cut 2 @ 4" lengths. Measure and mark 3/4" on each end and bend them up 90 degrees.

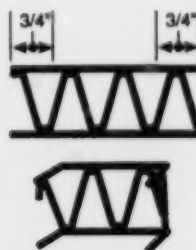


Figure 11 - Short Bent Truss



Integrated Activity Idea

Have students conduct a study of differences in construction practices in different parts of the world. Have them identify the reasons for the differences.



Soldering Runway

8. Making the runway assembly is quite simple. Combine the two long trusses by facing them together overlapping the ends by 1/2". Solder them together. **Instructor's Initials**

Hint: a clothespin with two thin grooves, (one on each jaw) can hold them steady while soldering.



Figure 12 - Main Runway Assembly



Technology Idea

Have an auto body technician or the autobody instructor from an AVTS speak to the class (or take a field trip to a body shop) about measures taken to impede rust and erosion in auto body repair.

Soldering Walkway

9. Next, be sure to center the walkway from the middle and solder to form a "T". Next, solder braces in the center of runway, completing the load bearing trusses.

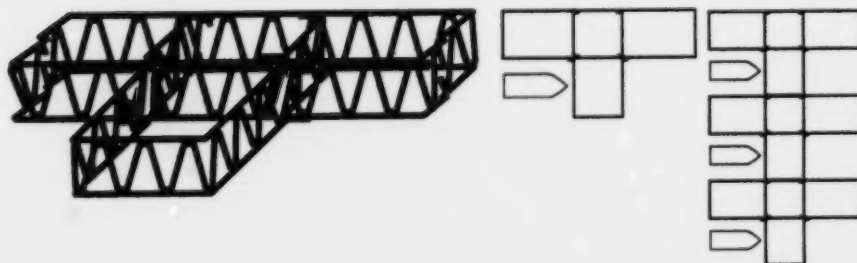


Figure 13 - Walkway Assembly

Weatherizing Metal

10. Since most metal trusses today are made from ferrous metals, such as steel which rusts, **coat** trusses (unless otherwise directed) with primer and paint to prevent from weathering. Ask instructor for proper application.

Cutting Decking Material

11. Using a deck cutting jig and hacksaw, cut wood strips to 2 5/8" lengths to make your walkway. Hot glue decking to the trusses. Coat with penetrating oil finish if desired.



Integrated Activity Idea

Conduct research into the chemical processes involved in the "decay" or corrosion of various materials (rust of ferrous materials, oxidation of aluminum, etc.).

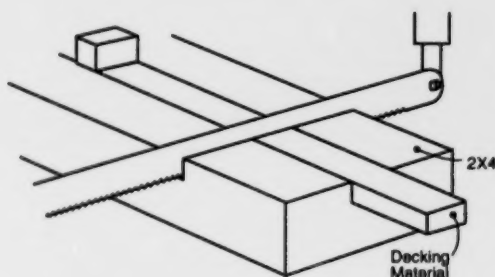


Figure 14 - Deck Material Cutting Jig



Integrated Activity Idea

Do a report of methods used to prevent (or impede) corrosion in a produced product (household appliance, automobile, buildings, etc.)

Cutting Flotation Pads

12. Styrofoam is a **polymer** which floats very well. Cut styrofoam with hot wire saw or utility knife into 2 1/2" x 2 1/2" pads. Caution: Do not touch cutting wire. It is extremely hot. Always use a piece of wood to remove pieces of styrofoam from the hot wire. Melted styrofoam is **very** hot. Hot glue pads below the ends and center of walkway.

13. Line a shallow wooden box, that is large enough for your boat dock, with plastic and add water. Test it out!

Materials Needed

Supplies

14-2 WG residential wire
.050 dia. rosin core solder
4D finishing nails
1/8 x 3/4 x 24 wood strips
3/4 - 2" styrofoam sheet
Hot glue
Primer and spray paint or oven
and powdered plastic

Equipment

100/140 watt soldering gun
Hot glue gun
Hot wire saw or utility knife
Wire stripper or pliers
Hacksaw
Linesmans pliers
Diagonal pliers
Truss forming jig
Deck cutting jig



Activity 3

Product Processing with Gravity (Roller) Conveyers

This activity will acquaint you to a method which is commonly used in transporting goods through a warehouse or to transport trucks. You will see how friction is reduced by wheels and axles. Each student will receive supplies to construct a section of a gravity conveyor.



Integrated Activity Idea

Consult your physics teacher on how to calculate load and force vectors for various friction coefficients and conveyor angles.

Procedure

Conveyor Core

1. Cut 1/8" hardboard into 6 pieces @ 2' x 12". Stack evenly and temporarily hot glue the ends together to keep them straight.

Hole Alignment

2. Using a drilling jig/fence, drill 9/64" holes 3/8" from the edge. Holes should be drilled 1" from the left end and every 3" afterwards. You should have four holes.

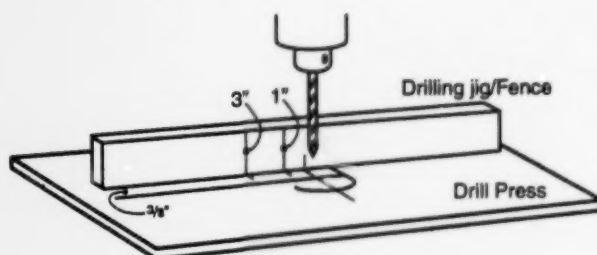


Figure 15 - Drill Press Setup

Cutting Spacers

3. Cut 3/4" pine into 10 pieces @ 2' x 1 3/4" for row spacers. **These must be square on each corner.**

Braces

4. Cut 1/8" hardboard into 2 pieces @ 2' x 9" for bottom braces.



Integrated Activity Idea

Compare and contrast the coefficient of friction between various setups including dragging on a flat surface and using the conveyor set on an angle.

Wheel Spacers

5. Cut plastic straws by **shearing** with scissors into 20 pieces @ 5/8".

Axle Assembly

6. Center wheels (CO₂ car wheels by **pressing** them onto the axles).

Sub Assembly

7. Lay one core strip on the table. Add a wood spacer down to allow for 1 3/4" rows. Carefully **fasten** with a hot glue gun around the corners. Position another at the opposite end, this time upright.
8. Repeat 4 more times.



Integrated Activity Idea

Study manufacturing changes in history and the development of materials handling.



Technology Idea

Interface the robot constructed in TAM 9 - Robotics with the conveyor system.



Technology Idea

Adapt the conveyor to include a powered roller at selected intervals to automate the system. You may wish to use small electric motors and sensors attached to a computer for controlled movement.

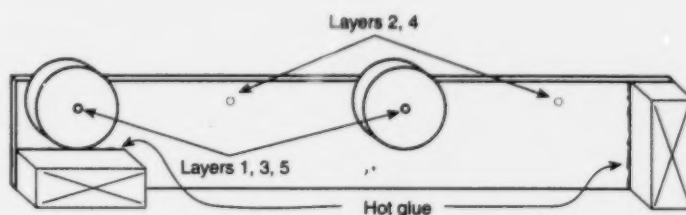


Figure 16 - Hot Glue

Wheel Final Assembly

9. Slip plastic straws over each half of an axle and place the first wheel in the far left hole and the next wheel in the third hole.
10. Stack the next layer on top but do not glue between first layer and the second. The second layer wheels should be staggered and placed in the second and fourth holes. If plastic straws slip inside the holes, tack edge with hot glue. Continue stacking until each layer is complete.

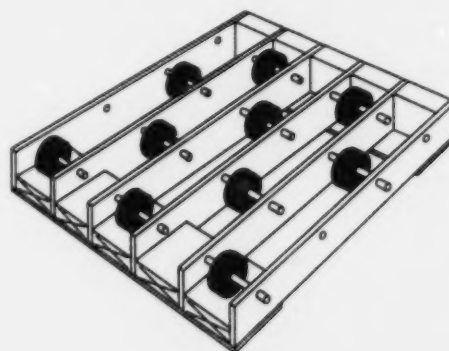


Figure 17 - Staggered Wheel Assembly



Wheel Alignment

11. Carefully lay the assembly on its back and line up rows so that all wheels are running in a straight line. Hot glue in the corner of each layer to temporarily hold it together.

Conveyor Bracing

12. Flip over, and using wood glue, adhere 2" x 9" strips to the backside on each end for strength.

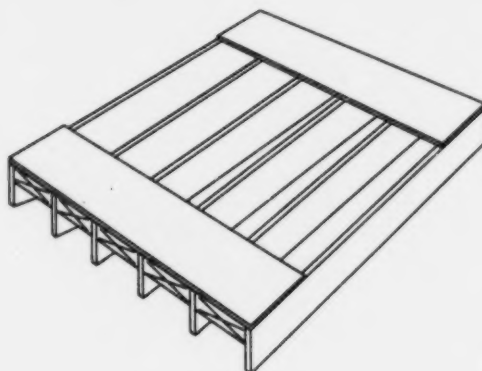


Figure 18 - Brace Attachment

13. Glue or fasten several conveyor assemblies end to end to make a long roller conveyor.



Integrated Activity Idea

Discuss the ergonomic effects of conveyors. Include results of investigations into proper conveyor height, speed, etc.



Technology Idea

Do a mass production run to make a large number of these sub-units. These sub-units can then be used in a subsequent mass production setup to make another product.

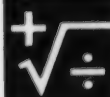
Materials Needed

Supplies

12" x 20" hardboard
2" x 24" pine
10 wide plastic CO₂ wheels
10 2 1/2" CO₂ axles
2 7 3/4" plastic drinking straws

Equipment

Table saw or band saw
Drill press
Drilling jig/fence
Hot glue gun
Scissors

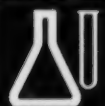


Integrated Activity Idea

Conduct a speed/time motion study to analyze the efficiency gained by using the conveyor system.

Activity 4

Lightweight Torsion Boxes



Integrated Activity Idea

Study strength to weight ratios of materials used to make the torsion box compared to the actual torsion box. How do you account for the differences in strength?

This activity will acquaint you with forces exerted on a thin slab and demonstrate its resistance to twist, bend, or warp. A torsion box is basically a thin box designed similarly to an airplane wing. It was designed so all applied forces stress the glue joints in the direction the glue is the strongest (shear). You will see that this cost-effective, dimensionally stable slab that is lightweight and is also quite strong.

Procedure

Cutting Core Strips

1. Rip 19 pieces of hardboard into 1" X 24" strips. **Have the instructor check the set up and demonstrate before making any cuts.**

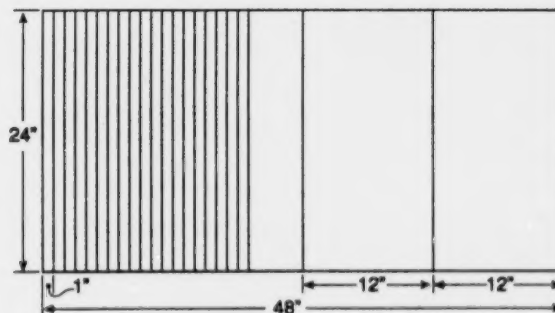


Figure 19 - Hardboard Ripping Setup



Integrated Activity Idea

Calculate the strength needed to hold two children on a teeter totter measuring 1" x 1' x 8'.

Cutting Panel Skins

2. Cut 2 pieces of hardboard into 12" x 24" pieces.

Table Saw Set Up

3. Clamp wooden miter-gauge extension with indexing pin to the table saw's miter-gauge so that the indexing pin is 1 3/4" to the right side of the blade. Set blade to a height of 9/16". **Have the instructor check the setup and demonstrate before making any cuts.**

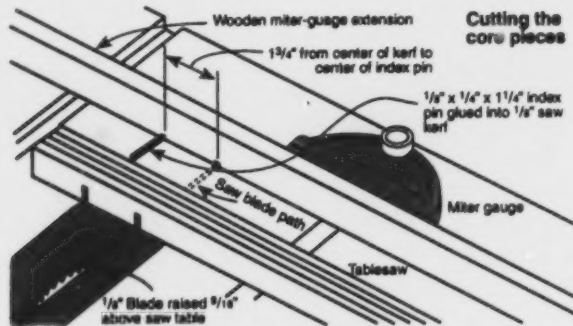


Figure 20 - Table Saw Setup

Cutting Grooves for Core

4. To make the core, stack 4 strips and **stand them on edge** and mark a line to show the leading edge. Slide them up against the indexing pin, carefully cut one pass. Next, position the kerf on the indexing pin, and make the second cut. Repeat the process all the way down. Stack 4 more and repeat the process for all 19 pieces.

Cutting Core Strips to Length

5. Using the band saw, cut 13 strips to a length of 11 1/4" (save scraps). Be sure to mark from the leading edge. Cut the remaining strips to 23 1/4".

Subassembly

6. Lay one 12" x 24" panel on the table. To make the core easier to assemble, use your scraps to temporarily hold the long strips facing up. Lay short strips in place to form a matrix (grid).

Instructor's Initials

The edges of the strips should be flush with each other.

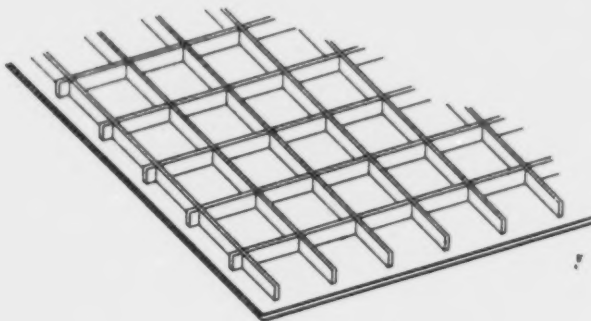


Figure 21 - Core Assembly Grid



Integrated Activity Idea

Do a study of the environmental impact achieved by the use of composite wood materials vs. solid wood.



Technology Idea

Disassemble a hollow-core door to examine its inner structure. Is this a torsion box?

Gluing the Core

7. Check to make sure the matrix is square. Spread wood glue over edges of the core with a glue roller or work fast by gluing each edge individually. (If edging is to be added, glue edging to strips on each edge.)

Gluing the Skins

8. Carefully, lay the other sheet on top making sure it is centered and square. Squeeze both sides and flip over and glue the opposite side.



Integrated Activity Idea

Explore and analyze the strength to spacing to weight ratios for various configurations

Clamping

9. Set panel on a flat, level surface. It will retain the shape it is glued next to. Lay a piece of 3/4" plywood on top and add weight (sandbag or quickrete) until it is dried.



Figure 22 - Torsion Box Assembly

You now have a torsion box. Set 2 x 4's under each end and stand on the final product. Add more weight if desired.

Materials Needed

Supplies

24" x 48" hardboard
3/4" x 12" x 24" plywood
Wood glue
Weight (sandbag, quickrete)

Equipment

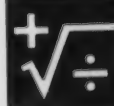
Table saw
Wooden miter-gauge extension with indexing pin
Wood clamps if desired instead of sandbag



Activity 5

Cam Operated Wood Bar Clamp

This activity will take you through the steps of making a cam operated clamp. It is extremely important to work safely and accurately. Have the instructor check the set up and demonstrate any job which you do not fully understand.



Integrated Activity Idea

Calculate the holding power when using different size cams and jaws.

Procedure

Cutting Jaws to Size

1. Rip $3/4"$ oak to $1\ 3/4" \times 36"$ pieces; then using a stopblock, cut to $5\ 5/8"$ lengths.

Pattern Layout

2. Using jaw template, trace pattern of jaw on each $1\ 3/4" \times 5\ 5/8"$ piece.

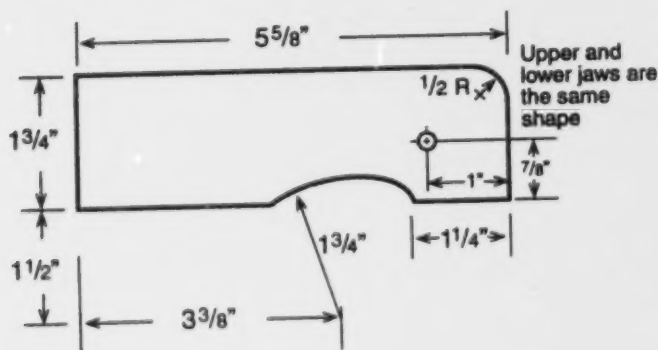


Figure 23 - Jaw Template



Integrated Activity Idea

Discuss the issues of child labor, women in the workforce, and other historical changes brought about through the development of mass production processes.

Cutting Jaws to Shape

3. Using the band saw, cut out upper and lower jaw.

Smooth Edge Surfaces

4. Using the disc sander, sand jaw edges smooth.

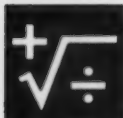
Cutting Groove for Each Jaw

- Using a jaw fixture and a table saw, cut a 1 1/2" deep groove through the end of each jaw. (Have your instructor demonstrate and double check for setting and operation.) Instructor's Initials



Integrated Activity Idea

Do a historical research project to trace the evolution of jigs, fixtures, and clamps used in industry.



Integrated Activity Idea

Do an experiment to determine the ratio of force applied to clamping force for a number of different clamping devices.



Integrated Activity Idea

Identify the different types of simple machines present in a variety of clamping devices.

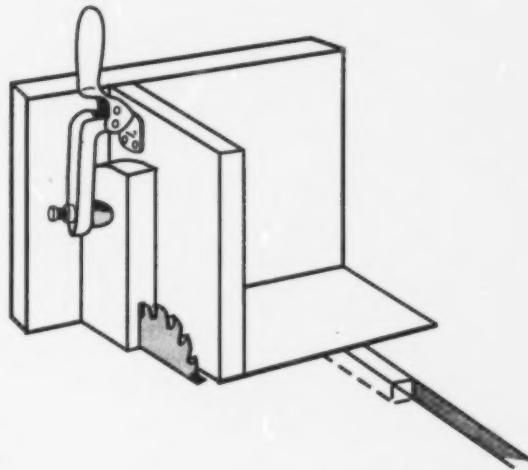


Figure 24 - Table Saw Setup

Pin Alignment

- Divide jaws into two piles (one for the upper jaw and one for the lower jaw). Using a pin alignment template, mark the location of wire brads for the lower jaws.

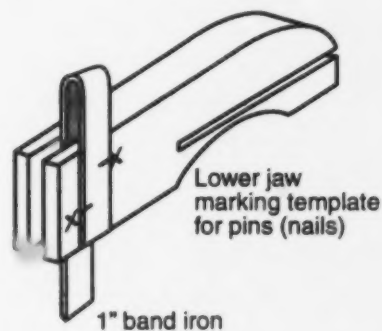


Figure 25 - Pin Marking Template



Tracing Cam Handles

- Using a cam template and 3/8 oak stock, trace cams to proper shape.

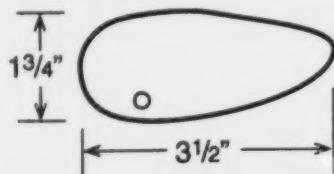


Figure 26 - Cam Template



Technology Idea

Set up a complete mass production exercise for producing the clamps. Place special emphasis on the design and development of jigs and fixtures. (See TAM 14 - Mass Production for additional details and ideas.)

Cutting Cams to Shape

- Using a band saw, cut cams to shape. Instructor's Initials

Sanding Cams Smooth

- Using a disc sander, sand cams smooth.

Cutting Groove for Cam on the Lower Jaw

- Using a milling machine or router table with stop, mill a 3/8" groove, 1 3/8" deep, 3 3/8" long. (Have your instructor demonstrate and double check for setting and operation.)

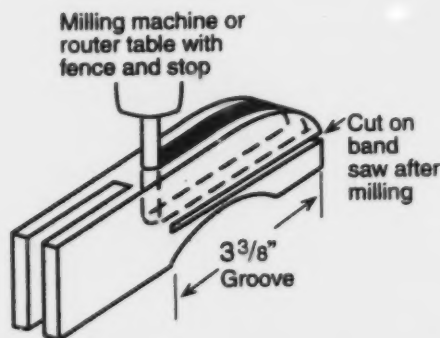


Figure 27 - Router Setup Detail



Integrated Activity Idea

Prepare a report focusing on the ergonomic aspects of tool and workplace design.

Cutting the Tail Piece for the Jaws

- Using a band saw, rip a piece of 3/4" x 6" x 20" oak into 1/8" strips. Then cut each strip into 1 3/4" lengths.

Gluing Tail Piece for Both Jaws

- Using a scrap piece of 1/8" x 1" flat iron and wood glue, glue in the tail piece and carefully slide out the band iron. Allow it to dry.

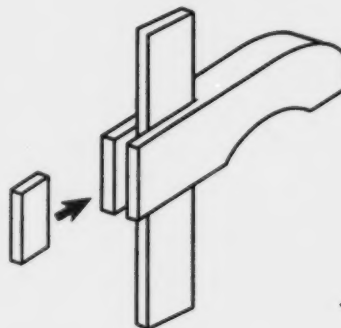


Figure 28 - Tail Piece Gluing Detail



Technology Idea

Make a list of the various types of clamps. Illustrate these with pictures. Then, discuss the applications, advantages, and disadvantages of each type.

Trimming Jaws

13. Using a band saw, trim the excess tailpiece off each jaw.

Cutting Dowel Pins

14. Using the band saw with a stop, cut 1/4" dowel rod to 3/4" lengths.

Fastening Cam to Lower Jaw

15. Slide cam into lower jaw. Using a drill press and 1/4" drill bit, drill a hole through the lower jaw on spot marked. The hole is for a dowel pin to hold cam in place. The hole should be made off center in the cam for maximum holding power. Have the instructor check for set up. Little glue, if any, will be necessary to hold the dowel pin in place.

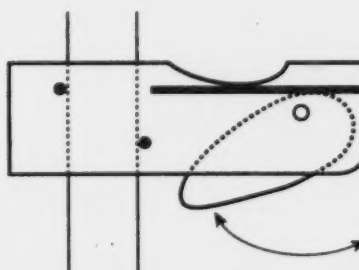


Figure 29 - Cam Attachment

Reinforce Lower Jaw

16. Using a 1/16" drill bit, drill on the spot marked for the wire brads. Drive wire brads into lower jaw with a hammer.



Cutting Band Iron to Length

17. Ask the instructor for desired length. Using a hacksaw, cut to length and then lightly file (or **grind**) off any burrs.

Jaw Stop

18. Using a 1/8" drill bit, drill a hole at the end of the band iron for a pop rivet jaw stop. Using a pop rivet gun, fix a pop rivet to the end of the band iron.

Fix Upper Jaw in Place

19. Slide lower jaw onto band iron facing up. Slide upper jaw onto the end and drill two 1/16" holes into the jaw and band iron for wire brads. Drive wire brads into upper jaw.

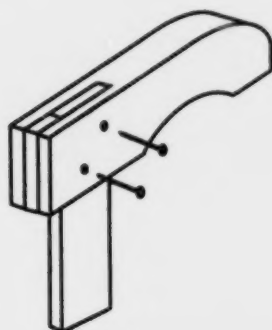


Figure 30 - Lower Jaw Reinforcement



Technology Idea

Prepare a complete set of working drawings for the clamp. If available, use a CAD system to complete your work.

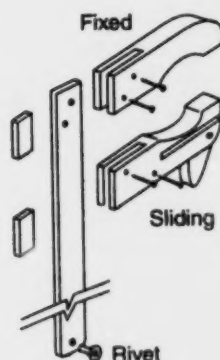


Figure 31 - Upper Jaw Assembly

Finish

20. Sand as desired, then wipe on penetrating oil finish with soft rag.
21. Work with your instructor to improve the quality of each piece for a better product tomorrow. For example, sandpaper glued to the clamping faces will reduce slippage of clamped objects. **Quality control** is an essential part of products being made today and employment tomorrow.

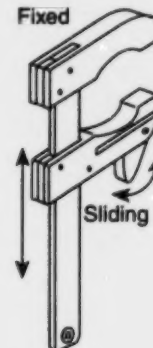


Figure 32 - Completed Clamp Assembly

Materials Needed

Parts

- 2 @ 3/4 x 1 3/4 x 5 5/8 oak
- 1 @ 3/8 x 1 3/8 x 3 1/2 oak
- 2 @ 1/8 x 1/2 x 1 3/4 oak
- 1 1/4 x 3/4 dowel rod
- 1 1/8 x 12-18 band iron

Supplies

- 3/4" oak
- 1/8" pop rivets
- drill bits
- 3/4" wire brads

Equipment

- Table saw
- Band saw
- Drill press
- Milling Machine or router table
- Surfacer
- Hacksaw
- Pop rivet gun
- Cam lever template
- Jaw template
- Finishing Sanders
- Pin alignment template
- Jaw fixture



Activity 6

Laser Assisted Deflectometer/Strain Gauge

If you've ever seen a tree sway in the wind, bridge bounce when a truck passes over, or diving board flex, then you understand how objects deflect or move when stressed. In this activity you will design and test samples of materials which may deflect under stress or strain. The stress applied may be compression, torsion, tension, or shear. With the use of a laser as an optical lever (or precision measuring devices such as dial indicators) accurate measurements can be measured to within .0001". If you cut one strand of your hair into twenty equal thinner hairs they might measure .0001".

For certain applications, dial instruments are impractical. Imagine measuring the sway of a tree or tall building with a 60' stand and dial indicator. A fixed mirror attached to the tree or building and a laser can more easily help in calculating deflection. The deflectometer or strain gauge is but one method to test for compression or tension. You may wish to design one to test for torsion (twist), shear, or bends in metals, plastics, ceramics, or composites (combinations) such as plywood or fiberglass.

Warning: Laser light can be harmful to the eyes. Do not aim beam directly into the eyes and cause retinal damage.

Procedure

Base Design

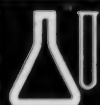
1. Lay out and cut a base made from 3/8" plywood to 24" square.

Fixture Design

2. Depending on the height of your laser, build a testing **fixture** to hold the testing material. This can be done by gluing a small wood block on a 4" piece of 2 x 4. You will need to space each for a 12" test sample. Screw each to your base along the edge starting at one corner.

Lever Design

3. Design a lever with wood or metal. This can be done by cutting some scrap wood to 3" x 4" and screwing a 3" x 12" to form an "L". Attach a hinge (door, tool box) to the end of the 3" x 4" piece between the two testing fixtures. The purpose of the lever is to provide weight and leverage to the testing apparatus.



Integrated Activity Idea

Work with the science department to assess the degree of mechanical erosion which occurs when ice separates rocks, earth or the swelling of earth when water freezes.



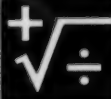
Integrated Activity Idea

Have a physics instructor team up with a technology teacher to explain the basic principles of optics and coherent light.



Integrated Activity Idea

Prepare a written or oral report describing how a grocery store bar code reader works.



Integrated Activity Idea

Work with the math and physics department to test the deflection of bleacher seats as students jump up and down at ball games. The mirror can be placed underneath with the laser while the game is being played.

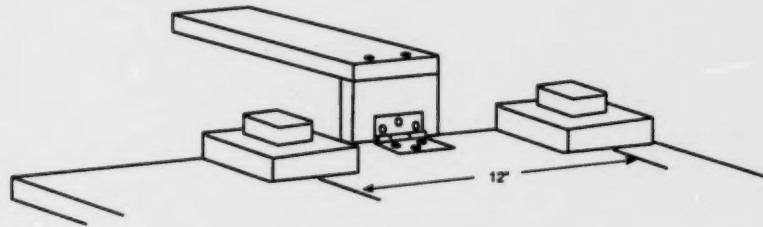


Figure 33 - Lever & Fixture Assembly

Mirror Stand

- Design and make a mirror stand from a **plastic** mirror and 1/8" wood strips. The mirror should be set near 45 degrees.

Instructor's Initials



Rear View

Figure 34 - Mirror Stand



Integrated Activity Idea

Research the use of lasers for surgery. What do they do and how do they work? Why are laser procedures improvements on traditional methods?

Measuring Scale

- Depending upon the distance from the mirror, you will need to curve the flexible rule (or use a file folder and graph paper) to the **same radius** from the mirror. If this is not accurate, no readings will be accurate.

Hint: the further from the mirror the easier it is to mark increments. Example: If the scale is placed very close then .001 deflecting in the material may only move the laser beam 1/32". Where as if you moved the scale back farther then .001 deflection might be 1" beam movement. Make your scale moveable for easier readings.

- Once the scale is made, either draw a circle on the test table of the same radius as the scale or, for several feet, use a tape measure to ensure accurate readings.



Technology Idea

Test the deflection of distant objects like a tree, a bridge over a river, a tall building, etc. To do this, you will need to attach a mirror to the object off of which to "bounce" the laser beam.

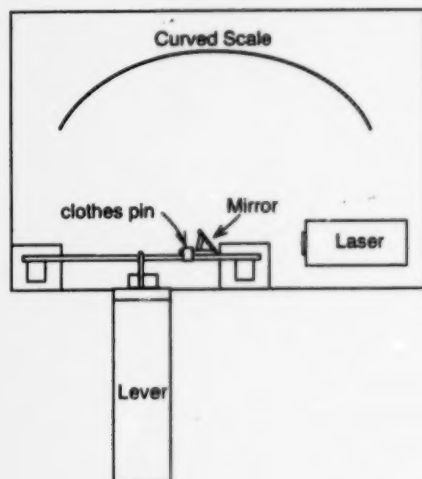


Figure 35 - Test Stand



Technology Idea

Adapt the deflectometer to non-destructively test the amount of deflection in a model bridge.

Test Hook

7. Using a screen door hook, attach screw eye to the lever at the same height as the material to be tested.

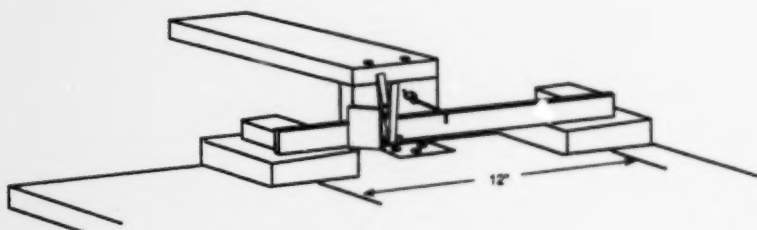


Figure 36 - Test-Hook Setup

Measurement Test

8. Lay a test sample in the fixture and clothespin the mirror stand so the mirror is at the edge of the fulcrum (right fixture) facing the laser. Turn on the laser and rotate scale to "0" or mark the graph paper. Slide a .002" feeler gauge under the front edge of the mirror stand and mark the location. The distance the laser moved has now been calibrated. Divide in half for .001" readings. You can try using other size feeler gauges and divide equally. The increments should be the same.

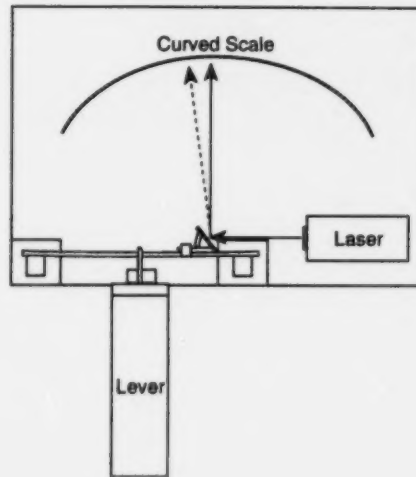


Figure 37 - Calibration of the Setup

Testing

9. Test various samples of materials and composites for the amount of deflection. (Wood, plastic, metal, fiberglass, ceramics, ice, etc.)

Materials Needed

Supplies

Various wood species cut to 1/8" strips 12" long
 Various plastic samples 1/8" x 12" long
 2" x 4" utility stud
 Screen door hook
 Plastic mirror
 Flexible rule or graph paper
 3/8" plywood
 Hot glue sticks
 3/4" drywall screws
 Paint
 Door hinge

Equipment

HeNe Laser w/glasses if required
 Table saw
 Band saw
 Hot glue gun



Activity 7

"X" & "Y" Axis Table

In this activity, you will be building an "X-Y" axis table which can be attached to the table of a drill press. This will allow the drill press to assume an essential feature of a milling machine. In milling machines, stepper motors are used to provide movement to the X and Y axes.

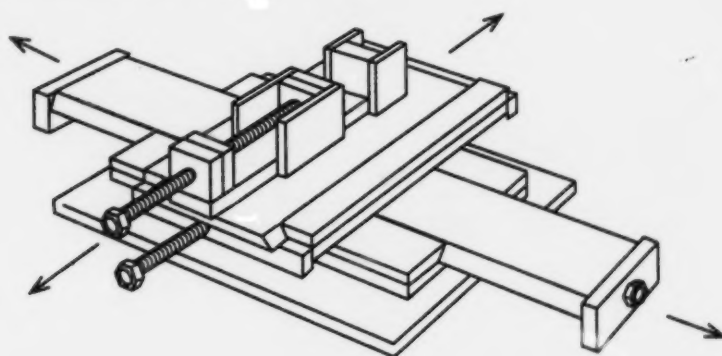
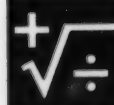


Figure 38 - Vice Assembly



Integrated Activity Idea

Develop graphs and associated coordinates of movements needed to "cut" an object. You may wish to incorporate basic concepts from trigonometry or matrix algebra.

Procedure

Base

1. Cut plywood into 12" x 13". Then draw diagonals to find the center. Using a drill press, drill a 1/4" hole through the base.

Cutting Way Holders

2. Using plywood, cut into 4 @ 3" x 12" and 4 @ 1 3/4" x 12" pieces. Then set table saw to an angle of 15 degrees and have the instructor demonstrate a safe method to cut the 4 @ 1 3/4" x 12" pieces. Glue bevel strips face down to the 4 @ 3" x 12" pieces. Be sure to remove excess glue in the grooves.

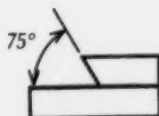


Figure 39- Way Holder Assembly



Technology Idea

This activity would make an excellent mass production. Refer to TAM 14 - Making What We Need and Want for information about doing a mass production exercise.

Cutting "X" & "Y" table

- Set table saw at 15 degrees and cut bevels for parts C and D. Draw diagonals on the bottom of part D to find the center. Using a drill press, drill a 1/4" hole through part D. The purpose of the lever is to provide weight and leverage to the testing apparatus.

Cutting End Caps

- Cut parts E and F to shape.

Drilling End Caps

- Using a 9/16" drill bit, bore holes in parts E and F.

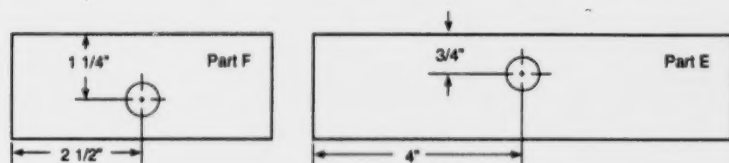


Figure 40 - End Cap Hole Locations



Technology Idea

This activity presents an ideal opportunity for a full scale mass production activity. Do this including all jigs & fixtures, assembly operations, and establishing a company.

Making the Vise

- Cut 3/4" oak into 6 pieces @ 1 1/2" x 2 9/16". Draw diagonals across one to find the center. Set up a fence w/stop or a jig to make each hole the same. Drill a 9/16" hole in the center of three blocks.

A. Threaded Section

- Drill a 3/4" hole, as deep as the thickness of the nuts used, in one piece. This will allow for the vise to thread properly. Using a hammer or vise, press a 1/2" nut into the 3/4" hole. Be sure it fits flush or slightly below the surface. Take one block with a hole and glue together hiding the nut in the middle.

B. Middle Section

- Take another block with a hole and bore a recess large enough to set a 1/2" ID washer slightly below the surface (about 1/8" deep); this should fit loosely. Next, carefully weld a washer to the end of the 10 1/4" all thread. This can be held squarely by using a nut and thread until the washer sets slightly higher than the rod. Grind or file smooth.
- Slide the all thread through the block until the washer end fits into the recess; then glue a solid block over the washer end hiding it in the middle. The washer should rotate freely inside the two pieces without binding.
- Cut jaw guides from 1/4" oak into 2 @ 2 1/4" x 4" and glue one on either edge of the middle section with the excess aiming with the all thread.



C. End Jaw

11. Glue two solid blocks together. Using 1/4" oak, cut jaw braces 2 @ 2 1/2" x 2 1/2".
12. Glue one on each end of the end jaw to be glued to the base later.

D. Vise Base

13. Cut 3/4" oak into 2 1/2"x10".

E. Assembly

14. Thread the all thread into the nut (threaded section) and check for smoothness in the middle section. If satisfactory, screw the threaded section down to one end of the base from underneath with 1 1/2" wood or drywall screws.
15. Next, screw the end jaw to the opposite end in the same manner being sure the jaws touch squarely when closed.
16. Weld a nut or handle to the end of the all thread to turn jaws in and out.



Technology Idea

Use a CAD system to complete all drawings for the vise. A special challenge would be to draw the threads.

Making the Center Drive Pins

17. The center drive pins will allow the table to move in an "X" or "Y" axis. The drive pins are made from 1/4" metal round stock cut to 7/8" lengths. Cut 2 of these squarely and file ends to remove burrs. To hold the rod steady while welding to the 1/2" nut, stand rod on end on a flat side to the nut. Use a metal vise to vise grip pliers, or a C clamp to hold it firmly. (Have the instructor double check prior to any welding and demonstrate how to weld properly).
18. Weld to the nut with either a MIG or an arc welder, being careful not to over weld the area. Instructor's Initials

Preparing All Thread

19. Using 1/2" all thread, cut to 1 @ 26 1/2" and 1 @ 18". File off any burrs.
20. Thread 1/2" nut to the end of the two longer pieces and weld flush.
21. Grind excess weld if necessary.

Final Assembly

A. "X" Axis

22. Place a drive pin into the 1/4" hole in the center of the base. Slide parts B, C, and B together so that the "X" screw (all thread) will be centered. (Hint, a clamp may be necessary to hold part B, C, B together.)
23. Screw both Bs (way holders) into the base to make part C fit tightly between.
24. Next, slip one washer and the end cap (part F) on and thread to the center drive pin. Fit the opposite end cap and level the drive screw.

25. When it is level and centered, drill pilot holes, and then screw end caps on to the "X" table (part C).
26. Add a washer and cinch two nuts to the end leaving little to no play.
27. Test for binding or looseness. Graphite or wax table for smoother sliding.

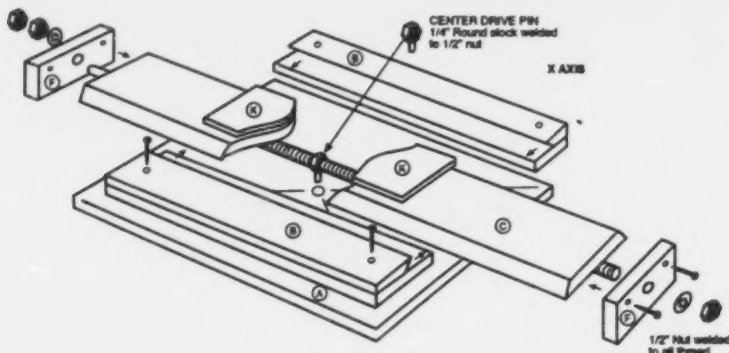


Figure 41 - X Axis Assembly



Technology Idea

Experiment with different methods and/or substances to reduce binding and friction along moving parts. For example, parafin wax is used to help wood-on-wood drawers slide more freely.

B. "Y" Axis

28. Press the other drive pin into the bottom of Part D making sure the drive screw will thread lengthwise. Cut part K (shims for the "Y" axis) 2 @ 1/4" x 2 1/4" x 4" and place beneath part B (way holders). They should be placed so when both way holders and the "Y" table (part D) are together they will be centered on Part C ("X" table).
29. Next, using the 18" screw, thread two nuts then one washer and Part E all the way to the welded end.
30. Thread the drive screw into the drive pin until it reaches the other end.
31. Next, place end cap on the opposite end and level and center the drive screw.
32. Drill pilot holes and screw end caps to way holders (part B & B) being sure of a snug fit for better accuracy later. (Hint, a clamp may be necessary to hold parts B, D, B together.)

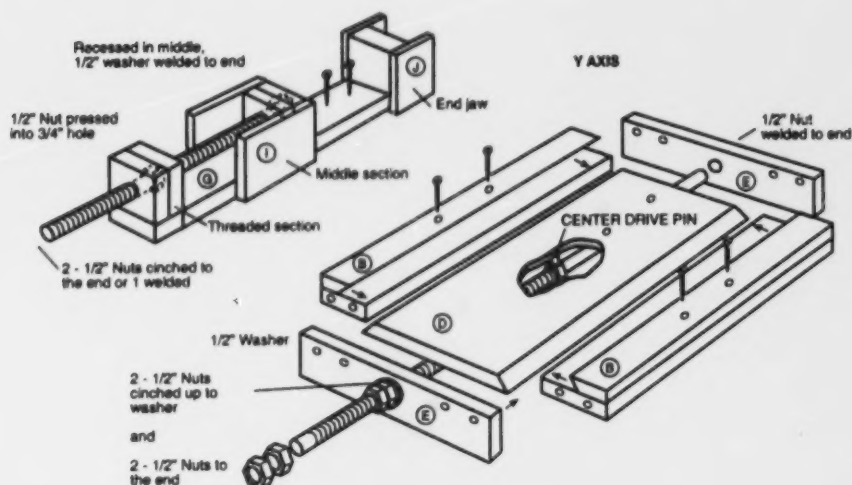


Figure 42 - Y-Axis Assembly

33. Add a washer and cinch two nuts to the very end. The two nuts next to the welded nut should be thread up to the end cap with little to no clearance. Graphite or wax table for smoother sliding.

C. Vise

34. Position the vise on the "Y" axis and screw into place. Test for operation of the vise.

Your "X" "Y" axis is ready for use with a drill press or dremel tool mounted on a stand and attached to the base. Power window motors, electric drills, cordless screwdrivers, or stepper motors can be added to turn the "X" "Y" axis to power the tables or use a hand crank made with a 3/4" socket. The table may be mounted to a drill press for machining, engraving or CNC demonstrations.



Technology Idea

Link the vise to the NC programming exercise in TAM 14 - Mass Production and Automated Manufacturing.



Technology Idea

Attach power window motors to the thread ends using wrench sockets. Use DPDT switches (Radio Shack) to control the movement. This could also be interfaced with a computer using relays (12 v. power supply).

Detailed Drawings

Due to the complexity of the vice assembly, the following drawings have been provided to assist in constructing the "X-Y" table.

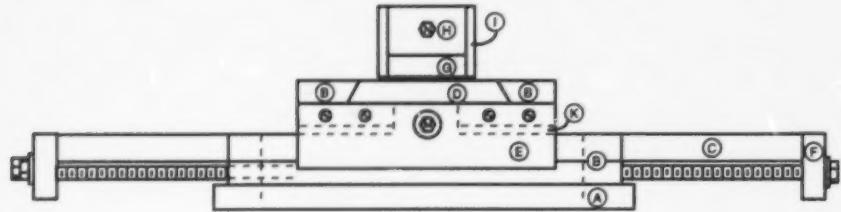


Figure 43 - Front View

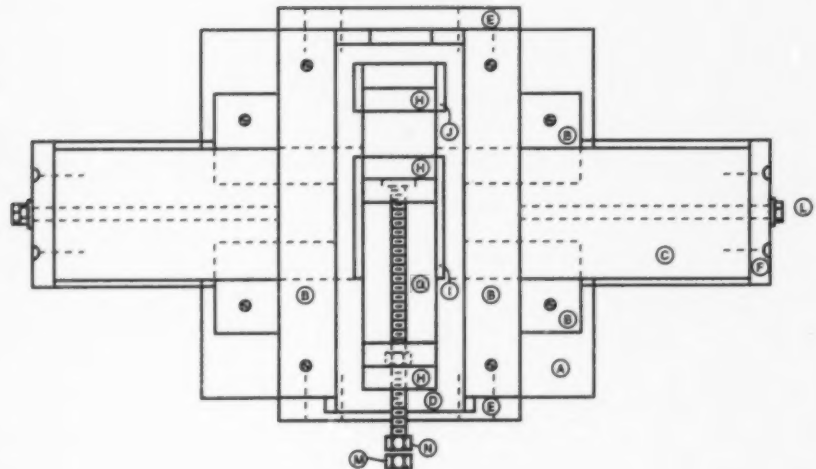


Figure 44 - Top View

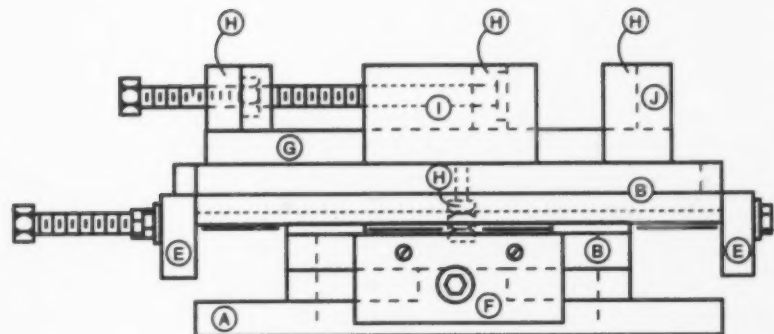


Figure 45 - Side View



Alternative Ideas

Y axis Mending plate or band iron

Mount one to base and one to way holders on bottom of "Y" table

Handles:

PVC:

2 @ 3/4" elbows

1 @ 3/4" pipe 4 1/2"

CPVC:

1 @ 3/4" x 1/2" adapter

1 @ 1/2" pipe 3"

1 @ 3/4" pipe 2 1/4"

1 @ 1/2" end cap

3/4" socket w/duct tape or epoxy

PVC:

1 @ 3/4" x 1 1/4" adapter

1 @ 1 1/4" end cap

3/4" socket w/duct tape or epoxy

Materials Needed

Part	Description	Quant.	Dimension	Material
A	Base	1	3/4" x 12" x 13"	Plywood
B	Way Holders	4	1 1/2" x 3" x 12"	Plywood
C	"X" Table	1	3/4" x 5" x 23"	Plywood
D	"Y" Table	1	3/4" x 5" x 12"	Plywood
E	"Y" End Caps	2	3/4" x 2" x 8"	Oak
F	"X" End Caps	2	3/4" x 2" x 5"	Oak
G	Vise Base	1	3/4" x 2 1/2" x 10"	Oak
H	Jaw Blocks	3	1 1/2" x 1 1/2" x 2 9/16"	Oak
I	Jaw Guides	2	1/4" x 2 1/4" x 4"	Oak
J	Jaw Brace	2	1/4" x 2 1/4" x 1 1/2"	Oak
K	"Y" Shim	2	1/4" x 2 1/4" x 4"	Oak
L	"X" Screw	1	1/2" x 26 1/2"	All Thread
M	"Y" Screw	1	1/2" x 18"	All Thread
N	Vise Screw	1	1/2" x 10 1/4"	All Thread
O	Washer	5	1/2" ID	Steel
P	Nut	10	1/2" NC	Steel
Q	Drive Pin	2	1/2" NC w/1/4" rod	Steel

Equipment

Table Saw

Jointer

Drill Press

MIG Welder

Assessment

Scoring Rubric for Activity 6 - Laser Assisted Deflectometer/Strain Gauge

Performance Standard	Wgt. %	Exemplary 2 pts.	Acceptable 1 pt.	Not Yet Acceptable 0 pts.	Sub total
I. Creative Thinker					
Based on current trends, speculate on the types of new materials which could be expected in the future.	x.5	Student lists 3 materials/properties that could improve any Activity 6 component.	Student lists 2 material/property that could improve any Activity 6 component.	Student does not list any materials/properties that could improve Activity 6 components.	2 x .5 = 1
Identify products that have been developed within the past decade using new materials.	x.5	Student identifies 3 new materials for deflecting/straining.	Student identifies 1 new material for deflecting/straining.	Student does not identify any new materials for deflecting/straining.	2 x .5 = 1
II. Critical Thinker					
Recognize and analyze the potential positive and negative impacts of the increased use of materials (renewable, limited, and unlimited resources) on students, their future unemployment, the environment and society.	x1	Student lists impacts and type of resources used for components and materials of Activity 6 (base, fixture, lever, mirror stand, measuring scale, and test hook)	Student lists impacts and type of resources used for 3 components and materials of Activity 6 (base, fixture, lever, mirror stand, measuring scale, and test hook).	Student lists impacts and type of resources used for less than 3 components and materials of Activity 6.	2 x 1 = 2
III. Contributing Citizen					
Discuss the relationship between materials harvest, development, and ecology.	x.5	Student discusses the relationship among all 3 variables.	Student discusses the relationship among 2 variables.	Student does not discuss any relationship among variables.	2 x .5 = 1
IV. Self-Directed Learner					
Demonstrate proper care and safe handling of all laboratory tools used in processing materials.	x1	Student shows proper care for and safely operates all laboratory tools.	Student shows proper care for and safely operates all laboratory tools with constant supervision.	Student does not show proper care for and/or safely operate all laboratory tools.	2 x 1 = 2
V. Problem Solver					
Discuss the factors affecting material selection including strength, weight, color, texture, etc.	x.5	Student solves Activity 6-based problems with no assistance from teacher.	Student solves Activity 6-based problems with assistance from teacher (less than 3 situations).	Student does not solve own problems or requires extensive assistance from teacher (>3)	2 x .5 = 1
VI. Effective Communicator					
Describe those practices and terms used in processing, including shaping, forming, combining, and removing.	x1	Student effectively communicates the project using the proper terms and processes at all times.	Student effectively communicates the project's terms and processes 70% of the time.	Student effectively communicates the project's terms and processes less than 70% of the time.	2 x 1 = 2
VII. Quality Producer					
Demonstrate the ability to work with highly specialized processing equipment, including those associated with forming, shaping, combining, and removing materials.	x2	The base, fixture, lever and mirror stand are all constructed to scale within teacher/project specifications and with no assistance.	The base, fixture, lever, and mirror stand are all constructed to scale within teacher/project specifications with assistance.	The base, fixture, lever, and mirror stand are not constructed to specifications or required extensive teacher interaction/supervision.	2 x 2 = 4
Practice all safety procedures when in the lab and when using the tools associated with materials and processes.	x2	Student follows all lab safety procedures at all times.	Student follows all lab safety procedures at all times with interaction/supervision of teacher.	Student does not always follow all safety procedures while in the laboratory.	2 x 2 = 4
VIII. Technical Foundations					
Identify the various foundation skills for different career options in materials and processes.	x.5	Student identifies 3 foundation skills for career options in laser technology.	Student identifies one foundation skill for career options in laser technology.	Student does not identify any foundation skills for career options in laser technology.	2 x .5 = 1
Identify typical applications in which materials and processes are effectively used in industry.	x.5	Student identifies 3 typical applications of lasers effectively used in industry.	Student identifies one typical application of lasers effectively used in industry.	Student does not identify any typical applications of lasers effectively used in industry.	2 x .5 = 1

Total: 20 out of 20 points



Short Answer Essay Questions - Activity 6

Laser Assisted Deflectometer

Name _____ Period _____ Date _____

Directions: In the blank on the left, write the correct answer to the statement or question.

(Material)

- _____ 1. Deflection of strip #1 (_____)
- _____ 2. Deflection of strip #2 (_____)
- _____ 3. Deflection of strip #3 (_____)
- _____ 4. Deflection of strip #4 (_____)
- _____ 5. Deflection of strip #5 (_____)
- _____ 6. Deflection of strip #6 (_____)
- _____ 7. Deflection of strip #7 (_____)
- _____ 8. Which strip had the most deflection?
- _____ 9. List three other materials or parts of products which should be tested for deflection to ensure product safety before sold on the market.

- _____ 10. Name two careers that deal with how materials deflect and resist breakage.

11. List, explain, and draw how you could use this tool to test a material or object for change when put under stress. You may not use any idea stated in the handout or from your instructor. No one else in the class may use the same idea. Be specific and be sure to label each part.

Activity Idea _____

Instructor's Initials _____

Description _____

Tech-Folio Check List

Portfolio Date _____ Name _____

Items which could be Included are:

Yes	No

1. Lists of new products that have been developed with new materials.
2. Design sketches and finished drawings of templates, jigs, and fixtures developed for the activity.
3. Lists of defined terms used in processing materials into a final product.
4. Product quality check-off for the TAM activities.
5. Research papers on the history of materials development.
6. Photographs of completed projects.
7. Student-developed plans of procedures for TAM activities.
8. Mass production records and technical reporting (if used to construct any of the products).
9. Other

Refer to page 82 of the Performance Based Education Handbook for a sample of how a portfolio could be scored.



Pre-Assessment

Name _____ Period _____ Date _____

Answer the following questions in full.

1. List five new products which have been developed in the past 20 years, due to new or existing materials, and give their application. (10 pts.)

Example: Lasers and bar codes/Pricing products faster.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____

2. List seven methods to process a material into a product. (14 pts.)

Example: Drilling, coating, etc.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____
- f. _____
- g. _____

3. List 5 materials, and their final product, which may be used in manufacturing. (10 pts.)

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____

4. Choose your favorite product sold today and list what materials and processes are necessary to produce it. (16 pts.)

Product: _____

Materials: _____

Processes: _____

Post-Assessment

Name _____ Period _____ Date _____

1. Below are areas that have used new materials or existing materials in a new way to be more efficient or safer. Identify a product that has been developed within the past 20 years using new materials or a material that has been used in a new way. (12 pts.)

Medical: _____

Construction: _____

Education: _____

Police protection: _____

Aerospace: _____

Military: _____

2. Imagine you are the Corporate Executive Officer (CEO) of the Mega Toy Corporation. To stay in business you must continue to develop new products. Before you spend hundreds of thousands of dollars on next season's line, how would you go about developing a new product for your stores? (Use as many steps as you see fit.) (10 pts.)

Step 1: _____

Step 2: _____

Step 3: _____

Step 4: _____

Step 5: _____

Step 6: _____

Step 7: _____

3. Explain the following terms: (13 pts.)

Brittle: _____

Coating: _____

Compression: _____

Deflection: _____

Elastic: _____

Forming: _____

LASER: _____

Raw Materials: _____

Shearing: _____

Soldering: _____

Tension: _____

Torsion: _____

Truss: _____

4. Explain how you would improve the overall design, development and appearance of the wastepaper basket backboard and hoop. (6 pts.)



5. Assume you are the senior manager in the Mega Boat Docks of America and your job is to build prefabricated boat docks. Using the experiences from this class, list the job titles needed to employ the personnel required to fabricate or build the orders. Assume that some jobs require more than one person so you don't have to duplicate jobs. (Use the substitution table to make it realistic) (2 pts. each/28 max)

MATERIALS

Your Model

Solder
Copper wire
Hot glue

Real World

Weld, rivet or bolt
Round or angle iron
Carriage bolts

POSSIBLE PROCESSES

Drill
Weld
Coat
Fasten
Press
Stamp

Bore
Grind
Rivet
Form
Saw

Cut
Combine
Extrude
Bend
Shape

Shear
Adhere (glue)
Forge
Heat treat
Turn

List as many as necessary

Job 1 _____	Job 8 _____
Job 2 _____	Job 9 _____
Job 3 _____	Job 10 _____
Job 4 _____	Job 11 _____
Job 5 _____	Job 12 _____
Job 6 _____	Job 13 _____
Job 7 _____	Job 14 _____

6. Explain why a torsion box has as much or more strength to prevent twisting or bending than a solid piece at a fraction of the weight. (6 pts.)

Complete the following statements. (2 pts. each)

7. A _____ is used to trace the pattern of an object to be processed.
8. _____ is an instrument which may use a laser to measure the movement of a material or object when exposed to stress or strain. (example: building sway)
9. _____ is the process of manufacturing goods, usually on an assembly line, frequently using interchangeable parts. (example, cars, stereos, etc.)



Instructor Resource

"Minds-On" Making

Content Outline

1. Categories of Materials
 - Organic (woods, plastics...)
 - Metallic (iron, steel, alum...)
 - Ceramic (cement, glass, abrasives...)
2. Properties of Materials
 - Physical
 - Chemical
 - Mechanical
 - Other
3. Types of Mechanical Separation
 - Shearing
 - Sawing
 - Milling
 - Other
4. Types of Forming
 - Casting/Molding
 - Pressure/Stretching
 - Extruding
 - Other
5. Combining Materials
 - Glueing
 - Soldering
 - Other
6. Jigs and Fixtures
7. New Materials
 - Ultra-Light/Strong Metals
 - Adhesives (aircraft)
 - Growth Hormone (food products)
8. New Processes
 - Prefabricated Structures
 - Smart Buildings
 - Manufacturing in Space
9. Careers in Materials and Processing
 - Professional (engineer, scientist)
 - Supervisory
 - Technical

Instructional Resources

Books

Thode & Thode, Technology (pp. 156-201). Delmar Publications .
 Instructional Materials Laboratory, University of Missouri MO Introduction to Material and Processing Technology
 Hacker & Barden, Living with Technology. Delmar Publications.
 Hoadley, Understanding Wood. Taunton Press.

Videos

Construction Tapes: Hometime
 Aerospace Technology: The Space Shuttle
 Engineering Technology: Welding Rod Bridge
 Robotics in Industry
 Woodshop Video Series
 Fundamentals of Laser Technology
 (See Pitsco, Hearnly, Modern catalogs, etc.)

Magazines

Kirby. (1982, Jan/Feb). Torsion Box. Fine Woodworking. pp. 96-102
Wood
Workbench
Laser World

Software

The Incredible Machine
 Bridge Builder
 CNC
 Printshop
 Page Maker
 Robotic Control Sys.
 Fund. of Lasers
 Computers in Manufacturing
 Computer-Aided Manufacturing
 (See Pitsco, Hearnly, Modern catalogs, etc.)



Glossary of Terms

Brittle: A material that breaks more easily than it bends.

Casting: Forming a product by pouring a liquid material into a mold, letting it harden into a solid, and removing it from the mold.

Ceramics: Materials that are made from clay or similar inorganic materials.

Coating: A combining process used to beautify or protect the surface of a material.

Combining: The joining of two or more materials in one of several ways, including fastening, coating, and making composites.

Compression: A force that squeezes a material.

Conditioning: Changing the internal properties of a material.

Conductor: Material that electricity can easily flow through.

Drilling: A separating process that puts holes in material.

Ductile: A material that bend more easily than it breaks.

Elastic: A material that bends and then returns to its original shape.

Extruding: A method of shaping soft materials by pushing them through an opening, therefore giving them the shape of the opening.

Fastening: The process of attaching one object to another.

Fixture: Work holding device to repeat an operation.

Ferrous metals: Metals made from more than 50% iron.

Forging: The process of heating and hammering a metal to shape it.

Forming: Changing a material's shape without cutting it.

Gluing: A method of fastening objects with adhesives.

Grinding: The process of removing small amounts of a material by rubbing it with an abrasive.

Heat-Treating: A conditioning process in which a material's internal properties are changed by the use of heat.

Industrial Materials: The intermediate step between primary raw materials and finished products. Primary raw materials are made into industrial materials, which are made into end products.

Insulator: A material whose atoms hold their outer electrons tightly, resisting the flow of electricity.

Jig: Holds and guides an item being processed.

Laser: Light Amplification by Stimulated Emission of Radiation. A laser is a source of very pure (single color) light that is focused into a very narrow beam.

Mass Production: Process of manufacturing goods, usually on an assembly line, frequently using interchangeable parts.

Plasticity: The property of a material that allows it to bend and stay bent.

Polymers: Materials, like plastics, which are made from long chains of molecules.

Pressing: A forming process where a plunger forces material into a mold.

Raw materials: Those extracted from the earth and processed into basic industrial materials or finished products.

Sawing: Sawing involves separating material with a blade that has teeth.

Separating: A category of processes that divide or put apart materials. Separating processes include shearing, sawing, drilling, grinding, shaping, turning, filtering, and chemical and magnetic separation.

Shaping: Processes used to change the shape or contour of materials.

Shearing: Using shears to separate materials.

Template: Reusable pattern.

Tension: A force that stretches an object.

Thermal: Having to do with heat or the transfer of heat.

Thermoplastics: Plastic materials that soften when heated.

Thermoset plastics: Plastic materials that will char and burn when heated. They do not soften.

Torsion: A force that twists an object.

Toughness: The ability of a material to absorb shock without breaking.

Truss: A carefully engineered, large prefabricated wood or metal section of a structure uses triangle shaped pieces.

Turning: A separating process where the material, not the cutting tool, moves. A lathe is an example of a turning tool.

Safety Factors

- Safety glasses must be worn while soldering and have proper ventilation. Remember: soldering irons get very hot and copper conducts heat very well, so gloves may be necessary.
- Laser light can be harmful to the eyes. Do not aim beam directly into the eyes and cause retinal damage.
- These activities should not be hazardous unless under conditions of prolonged, direct intrabeam viewing. Looking into the laser beam should be avoided at all time. When using class IIIa, IIIb, and IV lasers, use special laser eye glasses for protection.

Instructional Suggestions

- Walk through the TAM beforehand to locate problems your students will face. Also, having an example of the finished products helps them to understand what is expected.
- Have plenty of jigs or templates made prior to their usage. You never know when one gets lost or damaged.
- It may be easier to have some of the materials cut prior to each activity to shorten the completion time. You may want to have a couple of days of mass production: just getting the supplies cut to specification.
- Most of the TAM's activities are well-suited for use as mass production activities. See the mass production TAM (TAM 15) in this guide for more information.

Motivation

The activities in this TAM should be enjoyable experiences for the students. People remember the enjoyable experiences from their schooling. If you show motivation and enjoyment, they will too. Above all, have fun. Prime the students with the examples you've made.

- **Wastepaper Hoop** - a treat for the first to make a shot from 7 feet. Sell hoops at basketball games for \$3.00.



- **Boat Dock** - set a test tank on the table and have students brainstorm about additions to the completed dock, such as: a covered roof with skylights, sailboat designs, barge designs, submersibles, means of lifting boats from the water (pneumatic boat lift, cable/winch).
- **Gravity Conveyor** - demonstrate how easy it is to move objects of a few pounds across the room if several are attached end to end; or have a class project making one 8 feet in length or longer.
- **Torsion Box** - demonstrate the strength of the torsion box by having a student feel its weight and then stand on it.
- **Cam clamp** - demonstrate its holding power with two small pieces of plywood. Try to shake it loose. It will have around 60 pounds of clamping pressure.
- **Deflectometer** - demonstrate how simple it is to make an expensive tool, inexpensively, for calculating movements from large objects. Everyone is intrigued by lasers and their applications.

Prerequisite Information

Students should all be given demonstrations on tools and equipment prior to beginning individual work. Due to the age and maturity of students, and the nature of the activity, accidents can occur. Activities 1 and 2 could be easily done in the middle/junior high school, while all of the activities can be completed at the high school level.

Demonstrations

Demonstrations are necessary for the following applications:

- | | |
|--------------------|---------------------------|
| ■ table saw | ■ pop riveting |
| ■ band saw | ■ wood bending |
| ■ LASER operations | ■ jaw fixture |
| ■ surfacer | ■ gluing |
| ■ silk screening | ■ priming & spraypainting |
| ■ laser | ■ mig/arc welding |
| ■ soldering | ■ deck cutting jig |
| ■ drill press | ■ truss forming jig |
| ■ jointer | |

Remediation/Enrichment

Suggestions for working the special needs might include:

- Cooperative learning
- Assembly only
- Quality control
- Enrichment activities (spinoff ideas)
- Template, jig or fixture designers
- Activity set up or clean up

Related TAMS

- Introduction to Materials and Processing Technology Guide.
 - TAM 1 First Week Production Activity
 - TAM 5 Nondestructive Testing
 - TAM 6 Bridge Construction
 - TAM 9 Jigs and Fixtures
 - TAM 10 Automated Manufacturing
 - TAM 12 Mass Production
 - TAM 15 Leadership Development

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- Introduction to Energy and Power Technology Guide
 - TAM 3 Designing and Conducting Experiments
 - TAM 15 Making Lasers Work for Us
- 1990 Implementation Workshop TAMS
 - TAM 10 High Tech Low Cost Wood Technology
- 1991 Implementation Workshop TAMS
 - TAM 11 Laser Applications

Assessment/Evaluation Suggestions

- It would be a good idea to have a portfolio (folder or notebook) with a performance assessment checklist for each student. Have one displayed so that students can see what is expected of them.
- Have the student assume the responsibility of periodically bringing you the assessment sheet for you to initial or check off. If the sheets do not have instructor initials, no credit is issued. In business, evaluations are documented and then assessed for raises.

Note: Review the assessment items which are presented throughout the Performance Standards TAMS for ideas which can be adapted for this TAM. You should also refer to the Performance Standards Implementation Handbook for additional assessment examples and ideas.

Answer Key for Pre and Post Tests

Pre Test

1. Answers may vary such as:
 Kevlar: bulletproof vests
 Lightweight but strong plastic: automobile parts
 CD's: clear music
 Space shuttle: re-usable space transportation
 Action cameras: small portable video images for race cars, football players, etc.
2. Answers may vary such as:

Sawing	Shearing
Bending	Punching
Folding	Gluing/Adhering
Welding	Soldering
Stamping	Printing
Silkscreening	Scanning
3. Answers may vary such as:

Wood: Boomerang	Metal: Wheels
Plastic: Frisbee	Glass: Drinking glass
Sugar: Cakes	Corn Syrup: Pop
4. Answers may vary.

Post Test

1. Med: Fiber optics, sonograms, laser surgery, etc.
 Const: OSB Oriented Strand Board, Laminated I-joists, etc.
 Police: Kevlar bulletproof vests, Thermal heat scanners
 Aerospace: Space shuttle, shuttle tiles, satellite cameras, lightweight space suits, etc.



2. Answers may vary such as:
 - Brainstorm ideas for new line. (Define the problem)
 - Decide the target population. (Set goals)
 - Test for target population. (develop alternatives). Send free samples to schools, toy stores, hospitals, daycare centers, etc.
 - Get feedback & analyze data. (select the best solution)
 - Make a small number of toys and send the toys to stores for sale. (implement the solution)
 - Make a large number of toys or drop the line. (Evaluate results and make changes)
3. See key terms for definitions.
4. Answers may vary.
5. Answers may vary.
6. The strength lies in the core section. Gluing several pieces on edge puts all the stress on the glue joints making it lightweight but rigid because they are locked together.
7. Template.
8. Deflectometer or strain gauge.
9. Mass production.

Summary

In this TAM, students worked with several materials and tools. They learned to use templates, jigs, and fixtures. Throughout this unit they should have improved their communication skills while working with others. They have built models of real life manufacturing, and learned to manage time wisely to stay on task. The ability to cope with a rapidly changing environment and to produce usable products is a key element in manufacturing.

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Making What We Need and Want

Goal

This TAM is designed to explore some basic principles and techniques used in modern production and manufacturing settings.

Performance Standards



Mathematics



Communications



Science



Social Studies



Fine Arts



Health



Technology

- Describe the various components of automated systems, including materials handling, storage and retrieval, processing, inventory control, etc.
- Identify and analyze the positive and negative impacts of mass production/manufacturing/automated manufacturing on students, their future employment, and society.
- Define and describe the relationship between CIM, JIT, flexible manufacturing, group technology, and process planning.
- Comprehend how mass production/manufacturing/automated manufacturing operates as a social force, both positively and negatively.
- Identify and discuss the basic principles involved in mass production, including interchangeable parts, rate of flow, etc.
- Identify and describe specialized equipment which is typically used in automated manufacturing applications.
- Solve problems related to the design and construction of a mass production/manufacturing/automated manufacturing system.
- Define those practices and terms used in mass production/manufacturing/automated manufacturing, including basic jigs and fixtures, dry runs, CAD/CAM, CIM, and flexible manufacturing.
- Demonstrate the ability to work with specialized manufacturing equipment, including power tools, computers, computer-interface equipment, and programmable logic controllers.
- Practice all safety procedures when constructing mass production/manufacturing/automated manufacturing projects and when using any associated tools/equipment.



- Identify the various foundation skills for different career options in mass production and manufacturing/automated manufacturing, including materials, processes, and applications.
- Identify typical applications in which mass production/manufacturing/automated manufacturing is effectively used in industry.

Introduction

Many stories have been told about Henry Ford, the inventor of the Model T Ford. He was an inventor, a tinkerer, and a forward thinker. One of his life long goals was to develop products which could improve the lives of rural folk. He was constantly looking for ways to transform agricultural products into new materials which could be manufactured into things people wanted to buy. For example, Ford showed up at the Worlds Fair in Chicago wearing an outfit made out of synthetic soybean cloth. He was also an early experimenter with alcohol fuels and synthetic rubber (for auto tires) made from ragweed.

But Ford's most famous invention wasn't a product at all; rather it was a process! The process was the moving assembly line? Even here, there's an interesting story. One day Ford was being shown through a meat packing plant in Chicago. Beef carcasses were being routed throughout the plant on an overhead conveyor system. As a carcass passed a worker, an "operation" was performed (something was cut off). The bright idea came to Ford. Why not reverse the process and turn a moving disassembly line into a moving assembly line. As a result, the time needed to make a Model T Ford dropped from twelve hours and twenty-eight minutes to one hour and thirty-three minutes.

Throughout this TAM's activities, keep in mind that the "processes" involved in making things are every bit as important as the "product" itself. Without the process of mass production, many products would be of poor quality or so expensive you wouldn't be able to afford them. Imagine, for example, what it would cost to custom build a TV, stereo, or an automobile!

Objective Statement

The activities described in the following pages represent samples of activities which can be used to deliver the performance standards on page 1. Many additional activities can and should be used. Extreme care should be taken to connect each activity with appropriate activity objectives as well as with the above performance standards. These objectives should be developed by the instructor and should be shared with and made clear to the students.

Activity 1



Integrated Activity Idea

Keep thorough records in the form of a Techfolio. This should include a complete technical report of the process, design information, sketches, working drawings, CAD printouts, correspondence, accounting records, business forms, marketing information, etc. The techfolio should document the entire operation.

Establishing a Business

Many people dream of the opportunity of running and operating their own business. It's happened before. Plenty of times. Apple computer got its start with Jobs and Wozniak tinkering around with computer parts in a garage. The "Great American Dream!" Small businesses are a large part of what has made the United States a leading nation and a force in the global economy.

The purpose of this activity is to outline the procedures in setting up a mass production activity. It is designed so that the process could be used to manufacture many different products. Remember that word "process". That's the genius of mass production.

Procedure

The procedures which form this activity are designed to be adapted for use in mass producing any number of products. It's designed to be a simulation of how mass production works in the real world. Schools have made lots of products (toys, gum dispensers, tools, furniture, and more). The product can be almost anything. The process is what's important.

Activities 2 and 3 in this TAM will detail two products which can be mass produced by the class (a skateboard and a 2-way vise). For now though, let's look at the mass production process.

Most mass production situations consist of four stages.

- **Preplanning stage:** product and design brainstorming, setting product criteria, exploring organizational possibilities, etc. This stage involves preplanning activities which occur before a product has been selected.
- **Planning stage:** This is the stage in which the major planning occurs. This includes product, design, marketing analysis, financing, etc.
- **Production stage:** Production is the "meat" of the process. Here is where the "rubber hits the road". The product gets produced here.
- **Close down stage:** Every job requires some clean-up; mass production is the exception. But it is more than putting away tools and sweeping floors. The business must be closed out, and the product distributed.



Technology Idea

Visit a manufacturing plant and see how a product passes through the various stages of development in the real world. Explore with the owner (or other knowledgeable manager) the unique challenges and problems associated with each phase.



Manufacturing business must also have some sort of organizational structure. Most mass production situations do this by organizing into departments. These can be set up in various ways. For this TAM, there will be 5 departments.

1. Design/R&D/Prototyping

- Sketch the product.
- Develop the parts and materials list.
- Develop a complete set of full scale drawings.
- Choose hardware and materials.
- Select and finalize the design.
- Build a prototype for testing of durability, function, etc.
- Evaluate the prototype for necessary changes.

2. Production/Quality Control

- Develop a plant layout and product flow design.
- Proceed on correction of prototype with R&D, if needed.
- Make refinements to jigs and fixtures.
- Prepare a production schedule.
- Make plans for quality control.
- Complete a pilot run of the production line before full operation.
- Do any redesign or tooling needed to fix production line.
- Complete the full mass production run.
- Design and build jigs and fixtures.
- Coordinate production throughout operations.
- Keep an updated organizational chart which contains all of the worker's names.
- Organize any necessary Planning Committee meetings needed to alleviate problems.
- Clean up.

3. Marketing Sales

- Develop and implement market research (with assistance of R&D).
- Develop market questionnaire.
- Conduct market survey.
- Manage materials and supplies (amounts, kinds, and order).
- Prepare advertising budget and plan advertising campaign.
- Develop posters and displays about product.



Technology Idea

Set up a business and manufacture the 2 axis vise which is detailed in TAM 13 - Materials and Processes.



Integrated Activity Idea

Conduct a study of the history of manufacturing. You can do this based on individual leaders like Ford, Edison, Watt, McCormick, etc. What was their genius? Were they products of their time or were they exceptionally insightful and creative? You could also examine how technologies transferred from Europe to the U.S.



**Integrated
Activity Idea**

Work with the math and business education departments to establish complete accounting procedures for your business operation. As far as possible, computerize the entire bookkeeping and accounting process.

- Keep up with advanced orders and receipts.
- Design company name, logo, and product name.
- Handle all advertising.

4. Finance/Purchasing/Billing

- Work with departments to develop budgets.
- Collect all Departmental Budget Forms.
- Study market research results and decide upon the number of products that must be manufactured and their selling price in order to make a profit.
- Do a break-even analysis. Decide upon the amount of start-up money (capital) needed to begin operations.
- Set up stock for sale.
- Set up financial procedures (checking account at bank).
- Develop purchase order forms and simulate writing invoices and receipts.
- Prepare a schedule of reports to provide to department heads, to keep them aware of how much money they have spent.
- Finance may prepare Balance Sheets at regular intervals to tell the company how its income and expense compare.
- At the close of business, pay any remaining bill and prepare a finance balance sheet.
- Compute the company's profitability; then pay dividends to stockholders.

5. Personnel

- Prepare procedures for applications for employment.
- Schedule and conduct job interviews.
- Assign workers to departments and post their names on your Organizational Chart.
- Schedule and conduct elections for leadership positions.
- Hold meetings when necessary to solve problems between workers in the departments.
- Establish a schedule for inspecting the laboratory for possible safety problems.
- Schedule and conduct tours of your physical plant with visitors.
- Prepare Performance Evaluation forms to be used to rate the quality and amount of employee work.



Now that the stages and departments have been described, it is important to see how they fit together. Visually it looks like this.

	Preplanning	Planning	Production	Close Down
Design/Prototyping/R&D				
Production/QC				
Marketing and Sales				
Finance/Purchasing/Billing				
Personnel				

Figure 1 - Stage by Departmental Matrix

Figure 1 shows that all 5 departments have responsibilities which need to be carried out during each of the four stages. These responsibilities and duties will be outlined next. Keep in mind that these are just one way of conducting business. You will want to adjust these suggestions to fit your school's situation.

I. Pre-Planning Stage

During the preplanning stage it is recommended that all departments work as a group for part of the process.

- A. Start out by brainstorming a possible product that the class could mass produce. At this stage don't worry too much about whether it is feasible or not (although you probably don't want to get too much far "out there" or you've wasted time).
- B. Put the ideas up on a chart pad. (Note: This meeting may be conducted by the project manager. More information on selecting leaders for the project is provided below).
- C. Ideas could include:
 - ◆ Walkman
 - ◆ Candles
 - ◆ Skateboard
 - ◆ Bicycle
 - ◆ Model Car
 - ◆ Quilt hangers
 - ◆ Pen and Pencil set
 - ◆ Stools
 - ◆ Clocks
 - ◆ CD holders
 - ◆ Chess Set
 - ◆ Toys: Train set, trucks, biplanes, bulldozers, car, etc.
 - ◆ Bubble Gum Dispenser
 - ◆ Clocks



Integrated Activity Idea

Design a company logo. Use this logo on the product, on your correspondence, and on your report forms. Scan it or draw it using a desktop publisher or graphic design program so you'll have it in digital form.



Integrated Activity Idea

Conduct an ergonomic analysis of your mass production layout. Include considerations such as lighting, ventilation, lifting requirements, safety, efficiency and materials flow, etc.



Technology Idea

Invite an industrial engineer from a local manufacturing company to come to the class to discuss methods used in increase efficiency of their operation. What kinds of things have worked and what has not worked? What are they planning for the future?



Integrated Activity Idea

Select 3-4 industries as a class to visit and study. To do this, develop a list of items which define a manufacturing company's corporate culture (degree of control, levels of structure in the organization, openness to employee input, morale, etc.) Compare the companies. Why are the differences present?

- D. Now that you have a list of possible products, the next step is to brainstorm a list of process selection criteria. This is really important because these criteria will be used to help the company pick the best product.
- E. Brainstorm your ideas and capture them on a chart pad. The list could include criteria like:
 - ◆ Realistic (ability)
 - ◆ Realistic (money)
 - ◆ Realistic (time)
 - ◆ Profitable
 - ◆ Able to Automate
 - ◆ Jigs
 - ◆ Safety
 - ◆ Attractive
 - ◆ Facilities
 - ◆ Have needed equipment & tools
 - ◆ Materials available & reasonable
 - ◆ Is there a Market
- F. After the list of criteria has been developed, vote (secret ballot) which criteria should be most important. From the vote, the top 2-3 criteria will be identified.
- G. Next, go through the list of brainstormed products comparing them with your identified criteria. This will probably terminate a lot of product ideas.
- H. After the product list has been narrowed down, vote on the final product idea.

Setting Up The Organization

Another important component of the pre-planning stage is selecting and setting up an organizational structure for your company. Most companies are set up with a project manager (the main leadership role) plus departmental vice presidents. (You can choose to name them whatever you wish).

- Spend some time discussing the organizational structure as a class. Remember that you are attempting to simulate an actual manufacturing company. So, attempt to include "real world" considerations and trends into your planning.
- Keep in mind that the current emphasis is on "flattening" organizational structures (fewer people to report to and directly contact with the top people). Two very different organizational structures are shown below.



Integrated Activity Idea

Develop a report on the various types of organizational management structures which are used in businesses. How does organizational type relate to such factors as the age of the company, type of product/service, the personalities of those in charge, the culture of the local area, etc.? In general, do manufacturing businesses use the best type of structure for those types of organizations?

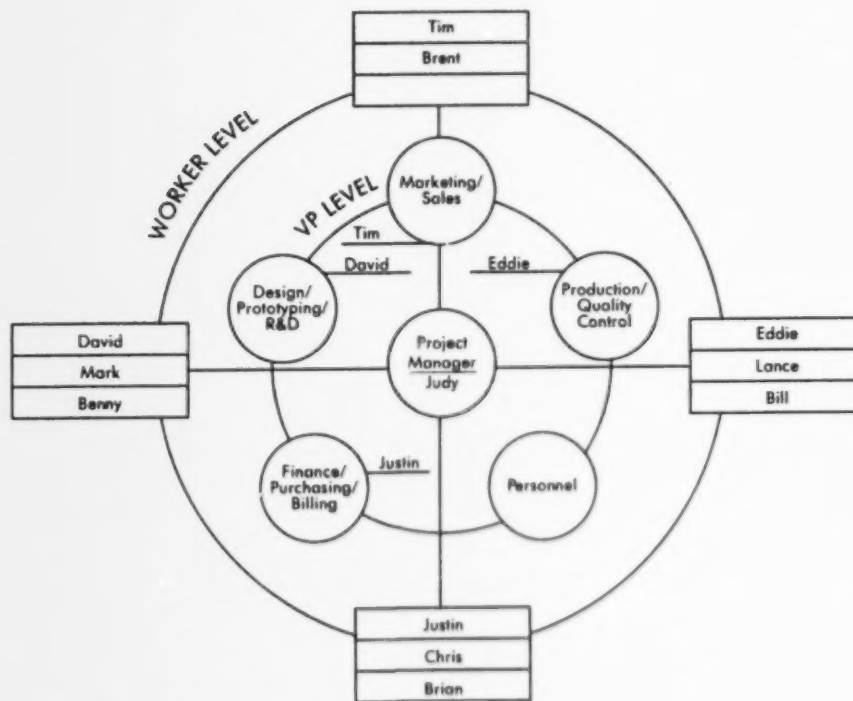


Figure 2 - Organizational Chart

- The other one is a more traditional organization as shown below:

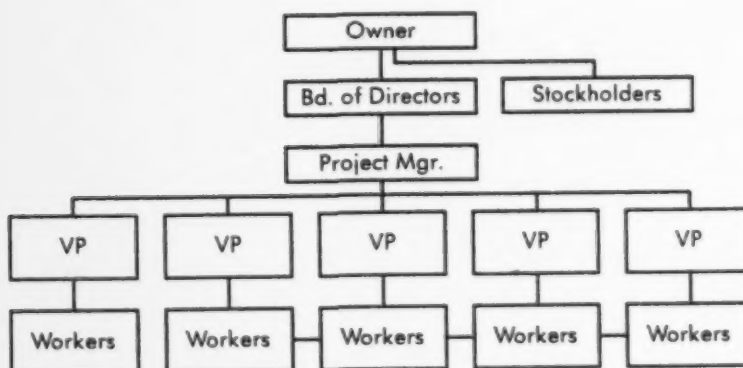


Figure 3 - Traditional Organizational Chart

- As a class, discuss the possible organization, including advantages and disadvantages of each of the options.

Departmental Activities During the Preliminary Stage

It can be necessary for each department to complete some preliminary activities during this stage.

- **Personnel:** The VP for personnel should be one of the first people selected after the project manager because he/she will be responsible for filling the rest of the departments with employees. Other activities include:

- ◆ Getting resumes of VP candidates for other departments.
- ◆ Developing plans for additional employee screening, interviewing, and selection.
- ◆ Further work on company organization.

- **Design/R & D/Prototyping**

- ◆ Prepare preliminary product design options for review by the whole group.
- ◆ Locate samples of similar products.
- ◆ Get design input from others.

- **Marketing/Sales**

- ◆ Preliminary and informal marketing analysis.
- ◆ Begin work in company logo.
- ◆ Brainstorm possible marketing strategies.

- **Finance/Purchasing/Billing**

- ◆ Identify tasks that will need to be done.
- ◆ Think about procedures, firms, and guidelines which will need to be put into place (bank account, capital, etc.).

- **Production/Quality Control**

- ◆ Preliminary review of equipment, tools, and facilities.
- ◆ Preliminary production flow idea development.

(Note: These tasks will vary depending on how you set up your company. This list is designed to get you started. You will want to add additional activities and customize it to fit your class.)

II. Planning Stage

- **Design/R & D/Prototyping:** Have the class do a process called ideation. Sketch many ideas then select the best one as the product. For example:

- ◆ Develop preliminary sketches.
- ◆ Develop refined sketches.
- ◆ Develop a complete set of working drawings.
- ◆ Build a prototype.
- ◆ Develop a parts list.
- ◆ Other.



Integrated Activity Idea

Do a study in the school or community to find out what kinds of techniques are most effective in marketing products. This can include such activities as interviews with successful marketing people, a survey, looking at articles, being alert to the kinds of things that catch your attention and appeal to you, conducting a person-on-the-street interview, etc.



- **Production/Quality Control:** Consider operation parameters by having the class assess the production rate that they will be required to produce.

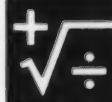
- ◆ Determine the quantity of each part needed.
- ◆ Develop a gantt chart of the overall process.
- ◆ Conduct safety analysis and plan for implementation.
- ◆ Other.

- **Marketing/Sales**

- ◆ Have the students develop ideas on how they could raise capital for producing the product.
- ◆ Have an understanding of the competition and know if they can meet or beat their competitors if any (sales forecasting).
- ◆ Develop and produce promotional program that stimulates the interest of the customers.
- ◆ Select company name.
- ◆ Develop marketing plan.
- ◆ Finalize logo.
- ◆ Finalize advertising materials.
- ◆ Conduct marketing research.
- ◆ Develop marketing budget.
- ◆ Other.

- **Finance/Purchasing/Billing:** The class should understand that all companies need money to operate, and when establishing their business most of their revenue will be generated from sales.

- ◆ A sales budget-estimates sales for a specific period. Have the student determine sales strategies (advertising, marketing).
- ◆ A production budget-have the class estimate the number of products needed to be produced to meet the sales budget.
- ◆ A production expense budget-have the class estimate the production costs. These costs include labor, materials, overhead (equipment, utilities, rent, etc.). Have the class determine their overhead and company costs.
- ◆ A general expense budget-have the class estimate the cost not directly related to the manufacturing of the product. This could include costs of marketing and administration, research and development, financial affairs, and industrial relations.
- ◆ Finally, have the class make a master budget that summarizes all costs.
- ◆ Collect departments budgets.
- ◆ Develop a Budget.
- ◆ Conduct a break even analysis.
- ◆ Set-up stock sale (if desired).
- ◆ Set-up financial details (bank).



**Integrated
Activity Idea**

Consult with the math teacher regarding appropriate processes for using statistics for quality control analysis. Obtain a Statistical Quality Control computer package for use on your manufacturing simulation.

**Integrated Activity Idea**

Develop a report dealing with the factors which have led to a major emphasis on quality in American manufacturing over the past decade. What are some of the major changes manufacturers have made? What have been the barriers? What has worked particularly well?

- ◆ Develop forms (purchase order, receipts, invoices, etc.).
- ◆ Set-up accounting procedures.
- ◆ Other.

III. Production/Quality Control

This is the stage you've been working towards. This is where the product actually gets built. During this phase the production department will take center stage. To some extent, the other departments become much less important. During production it will be necessary for everyone to become a production worker with the assigned stations and roles in the process.

- ◆ Conduct pre-production trial run.
- ◆ Work with personnel department to assign workers to jobs.
- ◆ Monitor safety.
- ◆ Monitor quality.
- ◆ Manage the production run.
- ◆ Manage assembly operations as necessary.
- ◆ Others.

■ Design/R & D/Prototyping

- ◆ Monitor design and adapt as necessary to accommodate production.
- ◆ Help with jig and fixture refinement.
- ◆ Others.

■ Marketing/Sales

- ◆ Continue to market to make certain all processes can be sold.
- ◆ Develop promotional materials to let community know about the mass production activity.
- ◆ Other.

■ Finance/Purchasing/Billing

- ◆ Manage and process purchasing.
- ◆ Handle sales and delivery.
- ◆ Maintain books and records.
- ◆ Other.

■ Personnel

- ◆ Handle employee complaints.
- ◆ Monitor personnel needs as outlined by production department.
- ◆ Other.

IV. Close Down

Voluntary dissolving of the company is also very important. Just as it was important to plan carefully at the beginning of the simulation. It is equally important to plan for how the project will be wrapped up. Again, each department will have some responsibility.



■ **Design/R & D/Prototyping**

- ◆ Debrief and evaluate design. How could it have been done better?
- ◆ Analyze quality dates and control problems. How did it go? What could have been done to have improved quality?
- ◆ Other.

■ **Production/Quality Control**

- ◆ Clean-up.
- ◆ Put facility and tools back into location specified by Instructor.
- ◆ Describe and evaluate production process. Analyze and critique it for recommended improvements. What worked really well?
- ◆ Other.

■ **Marketing/Sales**

- ◆ Complete product distribution.
- ◆ Collect payment for products.
- ◆ Issue receipts.
- ◆ Transfer funds to finance department.
- ◆ Other.

■ **Finance/Purchasing/Billing**

- ◆ Distribute funds to stockholders (if relevant).
- ◆ Pay bills.
- ◆ Close books.
- ◆ Develop final reports and balance sheets.
- ◆ Other.

■ **Personnel**

- ◆ Debrief group process.
- ◆ Develop productivity analysis and reports.
- ◆ Other.

You've done it! It is important to spend time debriefing the process because you'll probably want to do it again. But be sure to spend time thinking about what you learned, both about mass production and about the business world.



**Technology
Idea**

Discuss the design and problem solving processes. Detail and illustrate the steps. Consult Technology Education textbooks and magazines (The Technology Teacher, Tech Directions, TIES, etc.) where the process is discussed in more detail. Would you agree that problem solving is the technological method? Why? Why not?

Materials Needed

Forms

Computing equipment

Equipment and tools, as needed for production run.

Chart pad

White board

(Note: Some sample forms are included on the following pages).

Techno Products Inc.

Whippy Products Market Survey

The "whippy products" is a multipurpose (you describe it) case made with the Technology student in mind. It is a solid oak box with a dark stain finish, with brass hinges and simulated leather handle. This fine quality case measures 12" wide x 16" long x 2.5" depth.

1. Do you like the looks of the product?
_____ Yes _____ No
2. Do you think the product has been described well enough to buy it?
_____ Yes _____ No
3. Would you be willing to pay \$20.00 for this product?
_____ Yes _____ No
4. What do you like about this product? _____

5. What would you change about this product? _____

6. If you want this product would you pay half in advance and get a 10% discount on the final purchase price?
_____ Yes _____ No _____ NA
7. If interested in purchasing this product, please write your name and phone number where you may be reached.

Name: _____

Phone: _____

"Techno Products, Inc."
Production Schedule for Whippy Product

Operations	4/5	4/7	4/12	4/14	4/19	4/21	4/26	4/28	5/3	5/5
Parts ordered/recieved										
Rough Machining										
Jig & Fixture Production										
All parts cut out										
Assembly (hardware fit)										
Cut box										
Hardware										
Finish										
Final Assembly										



**DECISION TABLE**

Design 1: _____

Design 2: _____

Design 3: _____

Design 4: _____

Design 5: _____

Design 6: _____

Design 7: _____

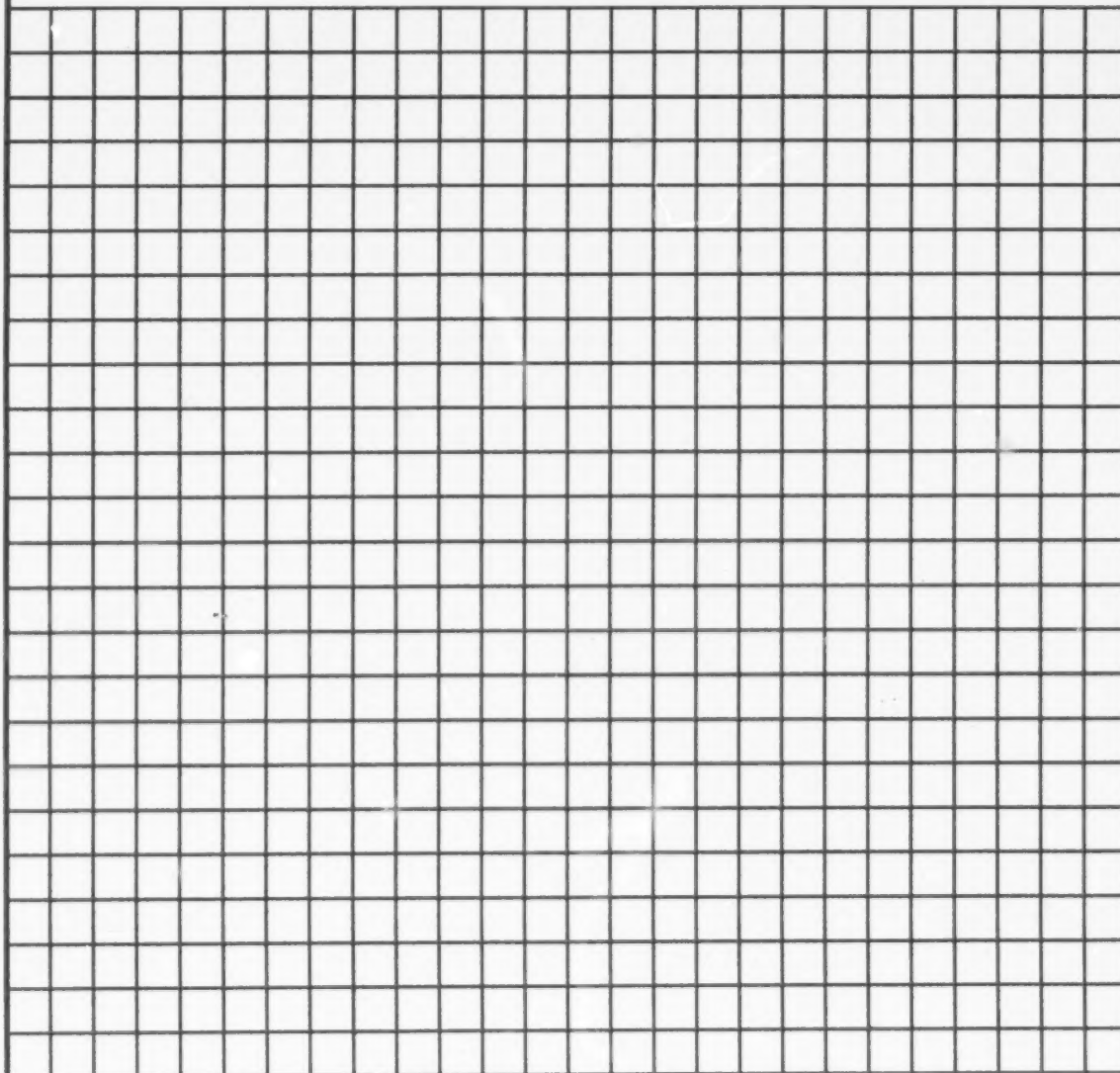
Design 8: _____

Factor Number	Factors to Analyze	Designs							
		1	2	3	4	5	6	7	8
1	Function								
2	Human Factors								
3	Market Analysis								
4	Strength								
5	Production Processes								
6	Cost Analysis								
7	Profitability								
8	Appearance								
9	Availability of Mat'l's/Components								
	Value Range 1 = Low Score 10 = High Score Totals								



Lab Layout and Flowchart

Scale _____ to _____



Directions: Draw to scale on the grid the dimensions of your laboratory, showing all doors, windows, and electrical outlets. Next, sketch in the best location for storage of raw materials and finished products, and all machining and finishing operations. Include arrows and lines which show the routing which the materials will take through the process.

INVENTORY

Tools & Equipment Needed

[illegible]

Time Study Form

[illegible]

Receipt Form

	Date: _____
Received From: _____	
for: _____	
the amount of: _____	
	By: _____

Purchase Order Form

PURCHASE ORDER		
Requested by _____ Dept. _____ Date _____		
Quantity	Description	Cost
Approved by _____		Total _____



Company Budget

ITEM
NUMBER

END 2ND QUARTER

	Income	Expense
1. Beginning Cash Balance		
INCOME		
2. Stock Sales		
3. Product Sales		
4. Borrowing		
5. Total Income (1 + 2 + 3 + 4)		
EXPENSES		
6. Materials		
7. Labor		
8. Overhead		
9. General Administrative		
10. Total Expenses (6 + 7 + 8 + 9)		
DISBURSEMENTS		
11. Payments to Stockholders		
12. Loans		
13. Loan Interest		
14. Payments to Others		
15. Ending Cash Balance		

(Finance Officer)

Activity 2



Integrated Activity Idea

Develop a historical report which traces the key people and events in the development of automated systems in manufacturing. This could deal with a specific aspect such as robotics, NC, mass production, etc. How have some of these processes been transformed into the service sector (such as mail sorting)? What do you think will happen by the year 2020?

Fischer Technik or LEGO Technic Kits

Another very realistic way of exploring automation is through the use of automation kits. Fischer Technik and Lego are two of the most popular. This activity is designed to extend TAM 10 - Automated Manufacturing from the M & P Guide by providing some additional scenarios which can be used to extend your exposure beyond those which have been developed by the company. Give them a try. They're very much like the problem solving situations faced by engineers and technicians in industry every day.

Scenarios

PLC-Fishertechnics Going Further

Level 1

Request for Automation

Project: Automated Drilling

Your team has been selected by the R&D division of the Tuffy Tractor Corporation to automate the drill press operations for a new (stealth) tractor. A PLC is used to control the sequencing in an automated boring operation. An operator loads the raw part into the fixture on the table and presses the start button S1. The drill spindle is engaged, feeds down into the raw part to a certain depth controlled by limit switch LS1, (located on the depth of cut gage) and then retracts to the home position. The fixture then indexes via motor (M1) to a second position (indicated by switch S2) where the drill operation is repeated. After the second drill operation has been completed, the spindle is shutdown and the fixture returns to its home position via motor M1, (home is indicated by switch HS). The operator then unloads the finished part, loads another raw part and starts the sequence again.

Level 2

Request for Automation

Project: Quality Control

Your design team has been contracted to automate the design of a system that checks the coating process of a part for a new jet fighter. The metal wafer will be picked up off a parts stand by a pick/place robot with a vacuum end effector (indicated by E1) and held over to a computer controlled vision system (indicated by V1) which checks for flaws on the bottom surface. The wafer will then be moved to the next station via motor (M1) where it will be placed and the robot end effector retracted so a second computer controlled vision system



(indicated by V2) can inspect the top surfaces. The water is then moved to a third station (via motor M1) where it waits until it is removed for packaging by a human operator (indicated by S3). The water must remain at rest for 10 seconds at station 1 and 14 seconds at station 2. The process must repeat after the operator has removed the part. You should use a light for each station indicating the computer vision inspection.

Level 2

Request for Automation

Project: Automated Ultraviolet Light

Your design team has been asked to automate a design which will deliver a metered amount of ultraviolet light for the purpose of hardening a part. This hardening process will be used for a new ultraviolet reactive composite material (which will be used to help make the worm drive for submarines). The part will lie on the exposure area. You must move the light via motor (M1) until limit switch (L1) has closed. This point may vary as the quality control dictates. After the exposure to the ultraviolet, the light must be retracted via motor (M1) until it reaches limit switch 2 (L2). The light must stay at this point for 15 seconds so the unloading robot can remove the part. The test part will need a total 15 seconds of exposure, 7 seconds of rest (curing time).

Level 4

Request for Automation

Project: Soda Production

Your team has been selected to automate the mixing process for the Super Soda Corporation. When the operator presses the start button (X1), it energizes the control key relay C1. This control relay turns on a solenoid (S1), which allows water to flow in the tank. When the tank becomes full the float switch (FS) closes (the contact is open until the fluid reaches the level). This opens relay C1, forcing S1 to be de energized, thus stopping the flow. It also activates a timer (T1), which provides a 120 second delay for any impurities to settle. At the end of the time delay, the timer (T1) energizes a second relay (C2), which controls two devices: (1) it energizes solenoid (S2), which opens a valve to allow the fluid to drain out of the tank; and (2) it initiates a timer (T2), which waits 90 seconds to allow the contents of the tank to be drained. At the end of the 90 second wait, the timer de energizes solenoid (S2), thus closing the outflow valve. Depressing the start button (X1) resets the timer and opens the respective contacts.

Level 5

Request for Automation

Project: Bread Proofing Control

Your design team has been selected to automate the proofing operation for Bennie's Breads of Doughville, MO. The conveyor proof box is fed by a continuous conveyor that carries pans from the bun production area. At the end of each bun production machine is a synchronizing conveyor. This conveyor must be programmed so that one and only one pan is fed to the transport



Integrated Activity Idea

Debate the effects of automation on people and society. Include factors such as worker displacement, employee satisfaction, working conditions, accuracy and precision of operations and products, etc. On the balance, has automation been good or bad for people? for the economy? for most businesses? for most communities?

conveyor at a time. There is a photo detector on each synchronizing conveyor to detect the pans. The synchronizing conveyor transports the pans (each pan is 24" x 30" and carries 20 large "Fun Buns") to a crossover conveyor which turns the pans 90 degrees and places the product on the transport conveyor. The transport conveyor carries the pans to the proof box loader area. When eight (8) pans have been detected by sensor (S1), and the eight (8) pans have stopped forward travel [as indicated by sensor (S2)], the loading rake pushes the (8) pans onto the empty conveyor shelf. The product stays on the conveyor until it has reached the end of the conveyor cycle, where at this time it is unloaded and fed to the depanner area. You must maintain the temperature of the proof box at between 99-105 degrees Fahrenheit (indicated by thermostats T1 and T2) and a relative humidity of 97 and 99% (indicated by H1 and H2). If either temperature or humidity is over/under range, you must sound an alarm to summon an operator. After the problem has been corrected, you must provide a way for the operator to turn off the alarm. In addition, you must turn off the air gate (a high speed blower which blows a curtain of air) at the opening of the conveyor proof box.

Materials Needed

Computer disk, blank, to suit available computer
Ground fault circuit interrupters (GFCI)
Starter Fischer Technique or LEGO Technic set
Motor or gear Fischer Technique or LEGO Technic set c/w (pneumatic systems, robot models, computer interface)
DC power supply
Machine Tool (advanced) Fischer Technique or LEGO Technic set
Additional sets such as: High level storage warehouse, three axis control model, flexible processing line, conveyor model, lifting table model, transporting and sorting model.



Activity 3

Numerical Control (NC) Programming

One important component in automation manufacturing is numerical control (NC). Not too many years ago, before the development and widespread use of computers, NC programs were stored on 1" rolls of paper with lots of holes punched in it. The principle was much like a player piano. Today, this technology has given way to computer control and is called computer numerical control (CNC). No matter what form the program storage takes the "language" is basically the same. NC or CNC is a form of programmable automation where the processing equipment is controlled by a means of numbers, letters, and other symbols.

Code Description

N	Define the line number
G	Prepares the controller to interpret the incoming data. Basically set up code.
M	Miscellaneous functions.
X	Movements in the "X" direction.
Y	Movements in the "Y" direction.
Z	Movements in the "Z" direction.
F	Specifies rate of tool travel.
S	Specifies rate at which spindle rotates.

G-Code Table

Code	Description
G00	Rapid travel
G01	Linear interpolation
G02	CW circular interpolation
G03	CCW circular interpolation
G70	Inch format
G71	Metric format
G90	Absolute programming
G91	Incremental programming



Technology Idea

Use a computer program such as Smartcam or Mastercam to translate CAD data to NC code. If not available, tour a manufacturing business which uses CNC and automated systems to watch a demonstration.

M-Code Table

Code	Description
M00	Program stop
M02	End of program
M03	Spindle ON CW
M04	Spindle ON CCW
M05	Spindle OFF
M06	Tool change
M07	Mist coolant ON
M08	Flood coolant OFF
M09	Coolant OFF

To actually manufacture using numerical control systems, an operation would have to employ the following three basic components 1) program of instruction, 2) machine control unit, and 3) processing equipment. This activity will introduce you to the world of NC programming through the use of simulation. After you have successfully completed this exercise, you will know how to do one of the major operations which is being used in automated manufacturing operations throughout the U.S. and around the world.



Technology Idea

Refer to TAM 13 - Materials and Processes for the activity which details plans for a 2 axis vise. Compare this to an NC mill. How are these very similar? Build the vise and automate it by attaching stepper motors to the lead screws. Control the stepper motors using a computer program.

Procedure

1. The first step in this activity is to get the NC computer simulation package. It is located on the MORETECH system for downloading to a DOS compatible computer. Note that unrestricted permission has been granted by the program's developer, so you may also feel free to share your copy with other teachers. To obtain downloading information you may send a request to **rcuster** and instructions will be forwarded to you.
2. Second, familiarize yourself with the machine tool coordinate system for NC prior to starting. The two axes, x and y are defined in the plane table, and the z axis is perpendicular to this plane. Movement in the z direction is controlled by vertical motion of the spindle, as shown in Figure 7.

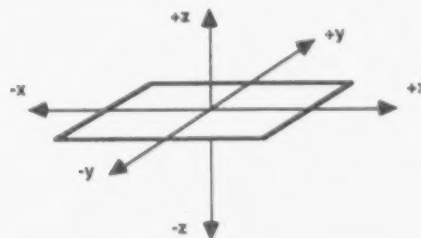


Figure 7 - NC Coordinate System



3. Before running your program it will first be necessary to develop your NC program using the "words" introduced above. Let's start by walking through an existing program. Once you understand how it works, you'll be ready to create a new one on your own.
4. Sample NC Program To Do RC Initials

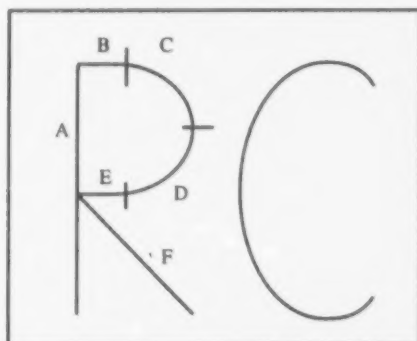


Figure 8 - RC Diagram



**Integrated
Activity Idea**

Consult with the math teacher to see how math functions are programmed into the NC controller to control the movements of an NC mill.

Sample NC Program

N01G00G70G91M06

N01-Line #1; G00-Rapid travel; G70-Inch format; G91-Incremental Programming; M06-Tool change. The main point which needs additional comment here is about the G91-Incremental programming command. The way this works is that every movement command which is issued is based on (calculated from) the end point of this previous command, not from some set reference point. In other words, the reference point will change every time the cutter changes position.

N02X02500Y02500Z0F800S500M03

N02-Line #2; X02500-Cutter moves .2500" inches in positive "X" direction; Y02500-Cutter moves .2500" inches in positive "Y" direction; Z0-No movement in "Z" direction; F800-Cutter travels at rate of 8 inches per min.; S500-500 RPM; M03-Turns spindle on in CW direction.

N03G01Z-.5000

N03-Line #3; G01-Cutter moves in a straight line; Z-.5000-Cutter moves in negative "Z" direction by .5000 inches.

N04Y3.0000

N04-Line #4; Y3.0000-Cutter moves in positive "Y" direction 3" (line A).

N05X10000

N05-Line #5; X10000-Cutter moves in positive "X" direction 1" (line B).

N06G02X07500Y-.7500I0J-.07500

N06-Line #6; G02-Circular movement; A more detailed comment must be made about circular Interpolation. Here's how it works. Note: first the I, J coordinates. These will be the center point of the arc (C). I0 indicates that the center point is "0" from the end point of the previous cut. Remember, that end points are our reference points in Incremental programming. The J-.07500 indicates that the arc's center point is in a negative "Y" direction by .7500" inches from the end point of the previous line. X07500 indicates that the arc's end point will be .7500" inches in a positive direction from the end of the previous line and Y-.07500 indicates that the arc's end point will be .7500" inches in a negative direction from the end of the previous line.

N07X-.07500Y-.07500I-.07500J0

N07-line #7; As described above the center point of the arc (D) will be -.7500" inches along the "X" axis with reference to the end of arc "D". Likewise, the center point of arc (D) will be "0" along the "Y" axis with reference to the end of arc "C". The "X" and "Y" end points of arc (D) are defined as "X" = -.7500 inches and "Y" = -.7500 inches again with reference to the end of arc (C).

N08G01X-1.0000Y0

N08-Line #8; Switch linear travel, 1" inch in a negative direction along the "X" axis.



Integrated Activity Idea

Interview mental health professionals in your community to get their perspective on the effects of various types of manufacturing jobs on worker mental health. What are the positives and the negatives?

From this point on you should be able to analyze the rest of the program.

5. Now you're ready to write a program of your own. Why not begin by "cutting" your own initials. After you've done that, you can develop a program to cut other shapes like those you might actually want to make on a real life NC mill.
6. First layout your initials on a piece of graph paper (to scale). Make your letters 3" tall. **Instructor's Initials**
7. Include radius lines rather than block lines. For example a "J" or "S" should include a semi-circle as shown in Figure 9.

J not J or S not S

Figure 9 - Letter Style Illustration

8. Develop your program to start inside rather than along the edge of your work piece, as shown in Figure 10.



not



Figure 10 - Letter Illustration

9. Raise and lower the cutter as necessary to cut only the letters and not the travel path between letters.
10. Key your program into a file using a line editor such as EDLIN or any word processor generating an ASCII file. Name your file anything you wish, up to 8 characters and then use the extension DAT. For example: TECH-ED.DAT or BILL.DAT.
9. Once you have completed your program, run it by completing the following steps:
 - a. Boot the program by typing GENIC<Return>.
 - b. Choose #7-for a Background Color (press return).
 - c. Choose #5-from the General Menu (press return).
 - d. Select Bridgeport Series I from the World Address Format Menu (type "a" and then press return).
 - e. Type the name of the data file that you developed with your NC code on it (press return after keying in the correct name of the file).
 - f. Select #1-Graphic Only, and press return.
 - g. Your program should go through its motions according to the path you programmed in.
 - h. While your program is running, watch the current NC Command Line to see what effect your command line is having on your cutter movement. Note that you will need to let the program complete its movement before you will be able to stop it and make changes. When it has completed its movements, it will ask you to type a "t" to terminate. Press "t".
 - i. If your program needs to be altered, go back to your file and make the necessary edits. (Note: If your program fails to work the first time, you're lucky. You'll learn more about how to develop NC code by debugging mistakes than you'll ever learn by getting it perfect the first time.

Materials Needed

Numerical Control (NC) program (GENIC)
IBM computer with EGA or VGA color monitor
Internet capability for downloading NC program
Modem 1200-up baud



Assessment

Scoring Rubric for Activity 2 - Fischer Technik or Lego Technic Kits (Level 2)

Performance Standard	Wgt %	Exemplary 2 pts.	Acceptable 1 pt.	Not Yet Acceptable 0 pts.	Sub total
I. Creative Thinker					
Describe the various components of automated systems, including materials handling, storage and retrieval, processing, inventory control, etc.	x1	Student correctly describes all components of Activity with a 90% mastery rate.	Student correctly describes all components of Activity with a 70% mastery rate.	Student describes all components of Activity with a below 70% mastery rate.	2 x 1 = 2
II. Critical Thinker					
Define and describe the relationship between CIM, JIT, flexible manufacturing, group technology, and process planning.	x1	Student correctly defines Level 2 components that meet CIM, JIT, etc. and their interrelationships with no errors.	Student defines Level 2 components that meet CIM, JIT, etc. and their relationships with less than 3 errors.	Student defines Level 2 components that meet CIM, JIT, etc. and their relationships with 3 or more errors.	2 x 1 = 2
III. Contributing Citizen					
Comprehend how mass production/manufacturing/automated manufacturing operates as a social force both positively and negatively.	x.25	Students report 3 examples each of how CIM/Mass Production has affected them positively and negatively.	Students report 1 example each of how CIM/Mass Production has affected them positively and negatively.	Students report 1 example or either positive or negative consequences of CIM/Mass Production.	2x.25 = .5
IV. Self-Directed Learner					
Identify and discuss the basic principles involved in mass production, including interchangeable parts, rate of flow, etc.	x.5	Design Team reports basic principles of the ultraviolet light project with no errors.	Design team reports basic principles of the ultraviolet light project with less than 3 errors.	Design team reports basic principles of the ultraviolet light project with 3 or more errors.	2 x .5 = 1
Identify and describe specialized equipment which is typically used in automated manufacturing applications.	x.25	Student contacts local industry and reports findings; technical report has no errors.	Student performs literature report and reports findings; technical report has no errors.	Student does not participate, report findings, and/or technical report has errors.	2x.25 = .5
V. Problem Solver					
Solve problems related to the design and construction of a mass production/manufacturing/automated manufacturing system.	x1	Design team successfully solves all problems with limited assistance from teacher (fewer than 3 situations).	Design team successfully solves all problems with average assistance from teacher (3-5 situations).	Design team does not successfully solve all problems or requires constant assistance from teacher (more than 5 situations).	2 x 1 = 2
VI. Effective Communicator					
Define those practices and terms used in mass production/manufacturing/automated manufacturing, including basic jigs and fixtures, dry runs, CAD/CAM, Ck: and flexible manufacturing.	x1	Student successfully completes a written essay test covering all practices and terms as identified by text/teacher with no errors.	Student successfully completes a written essay test covering all practices and terms as identified by text/teacher with fewer than 4 errors.	Student successfully completes a written essay test covering all practices and terms as identified by text/teacher with 4 or more errors.	2 x 1 = 2
VII. Quality Producer					
Demonstrate the ability to work with specialized manufacturing equipment, including power tools, computers, computer-interface equipment, and programmable logic controllers.	x2	Design team correctly constructs/ programs scenario with no errors and limited teacher assistance (fewer than 2 situations).	Design Team constructs/ programs scenario with no errors and average teacher assistance (2-4 situations).	Design team final scenario has 1 or more error and/or required above-average teacher assistance (5 or more situations).	2 x 2 = 4
Practice all safety procedures when constructing mass production/manufacturing/automated manufacturing projects and when using any associated tools/ equipment.	x2	Design team practices all safety procedures at all times.	Design team practiced all safety procedures while under direct supervision of teacher.	Design team did not always practice all safety procedures, regardless of supervision level.	2 x 2 = 4
VIII. Technical Foundations					
Identify the various foundation skills for different career options in mass production and manufacturing/ automated manufacturing, including materials, processes, & applications.	x.5	Student writes a technical memo that identifies 3 foundation skills each in materials, processes, and applications with no errors.	Student writes a technical memo that identifies 1 foundation skill each in materials, processes, and applications with no errors.	Student does not identify any foundation skill or commits errors in writing assignment.	2 x .5 = 1
Identify typical applications in which mass production/manufacturing/ automated manufacturing is effectively used in industry.	x.5	Student locates 3 sources from local industries that use mass production, CIM, etc.	Student locates 1 source from local industries that use mass production, CIM, etc.	Student locates no sources from local industries that use mass production, CIM, etc.	2 x .5 = 1

Total: 20 out of 20 Possible

Manufacturing Evaluation of Employees

	Poor									Excellent
1. Gave 100% effort throughout the class.	1	2	3	4	5	6	7	8	9	10
Comments: _____										
2. When given individual responsibilities they carried through with the work.	1	2	3	4	5	6	7	8	9	10
Comments: _____										
3. Completed all company responsibilities in a timely manner.	1	2	3	4	5	6	7	8	9	10
Comments: _____										
4. Worked as a team member (or class member).	1	2	3	4	5	6	7	8	9	10
Comments: _____										
5. Demonstrated positive attitudes during class.	1	2	3	4	5	6	7	8	9	10
Comments: _____										
6. Worked beyond what was required.	1	2	3	4	5	6	7	8	9	10
Comments: _____										
7. Punctuality and attendance.	1	2	3	4	5	6	7	8	9	10
Comments: _____										
8. Volunteered for any work assigned necessary to get the job done.	1	2	3	4	5	6	7	8	9	10
Comments: _____										
9. Let others' options be heard.	1	2	3	4	5	6	7	8	9	10
Comments: _____										
10. Was qualified to complete the assigned job.	1	2	3	4	5	6	7	8	9	10
Comments: _____										

Your Signature: _____



Effective Team Evaluation Rubric

- A. How clear are the group goals?
 - 1. No apparent goals
 - 2. Goal confusion, uncertainty, or conflict
 - 3. Average goal clarity
 - 4. Goals very clear
- B. How much trust and openness was in the group?
 - 1. Distrust, a closed group.
 - 2. Little trust, defensiveness
 - 3. Average trust and openness
 - 4. Considerable trust and openness
 - 5. Remarkable trust and openness
- C. How much attention was given to process (the way the group was working)?
 - 1. No attention to process
 - 2. Little attention to process
 - 3. Some concern with group process
 - 4. A fair balance between content and process
 - 5. Very concerned with process
- D. What kind of leadership was there in the group?
 - 1. No leadership
 - 2. Leadership concentrated in one person
 - 3. Some leadership sharing
 - 4. Leadership functions distributed
 - 5. Leadership met creatively and flexibly
- E. How were group decisions made?
 - 1. No decisions could be reached
 - 2. Made by a few
 - 3. Majority vote
 - 4. Attempts at integrating minority vote
 - 5. Full participation and testing consensus
- F. How well were group resources used?
 - 1. One or two contributed, but others silent
 - 2. Several tried to contribute, but were discouraged
 - 3. Average use of group resources
 - 4. Group resources used and encouraged
 - 5. Group resources fully and effectively used

Pre-and Post-Test

1. The department that trains people is...
 - a. Marketing
 - b. Research and Development
 - c. Personnel
 - d. Finance
2. A special tool that holds a part is called a...
 - a. jig
 - b. fixture
 - c. vise
 - d. template
3. Which department is responsible for advertising...
 - a. Finance
 - b. Marketing
 - c. Personnel
 - d. Production
4. The department that conducts job interviews is...
 - a. Marketing
 - b. Production
 - c. Finance
 - d. Personnel
5. The department that sells a company's product is...
 - a. Finance
 - b. Marketing
 - c. Personnel
 - d. Production
6. In order to speed the process of laying out large numbers of identical parts a _____ is used.
 - a. rule
 - b. dividers
 - c. template
 - d. jig
7. Which of the following are principles of mass production...
 - a. Labor is specialized
 - b. Interchangeable Parts
 - c. Uses machines
 - d. All of the above
 - e. None of the above
8. A device that locates a piece of work and guides the tool is...
 - a. fixture
 - b. jig
 - c. clamp
 - d. template
9. The owners of a corporation are...
 - a. Board of Directors
 - b. Vice Presidents
 - c. Taxpayers
 - d. Stockholders
10. Product planning includes...
 - a. the idea
 - b. drawings
 - c. prototype
 - d. production planning
 - e. all of the above
11. Interchangeable parts are...
 - a. precision parts
 - b. same size and shape
 - c. accurate
 - d. all of the above
 - e. none of the above
12. The process of putting all of the parts of a product together is called...
 - a. sub-assembly
 - b. capital
 - c. mass production
 - d. final assembly
13. The money raised by stocks is called...
 - a. payroll
 - b. capital
 - c. profit
 - d. revenue
14. A flowchart shows...
 - a. rate of flow
 - b. floor plan of a factory
 - c. path materials follow through work stations
 - d. parking space for company employees



15. The research and development department...
 - a. sells stock
 - b. makes prototypes
 - c. advertises
 - d. none of the above
16. A profit results when...
 - a. Income is greater than expenses
 - b. Income is less than expenses
 - c. Income is equal to expenses
17. The consumer...
 - a. makes the product
 - b. sells the product
 - c. distributes the product
 - d. uses the product
18. The producer is one that...
 - a. uses the product
 - b. makes the product
 - c. sells to the consumer
 - d. none of the above
19. Inventory is...
 - a. the number of employees
 - b. the amount of money in the bank
 - c. the amount of materials, tools and equipment on hand
 - d. none of the above.



By Joe Scarcella & Rod Custer

Instructor Resource

Making What We Need & Want

Content Outline

1. Background Information

- Key Terminology
- History of Automation

2. Components of Automated Systems

- NC & CNC
- Robots
- Automated Materials Handling
- Automated Assembly
- Automated Quality Control

3. Types of Production Systems

- Mass Production
- Flexible manufacturing (FMS)
- Just in Time Mfg. (JIT)
- Computer-Integrated Mfg. (CIM)

4. Future of Manufacturing

5. Careers in Manufacturing

Instructional Resources

Books

- _____. (Quarterly). *Fischer Technik Newsletter*. Fischer America Inc., 1904, Oostburg Court, Modesto, Ca. 95956, (209)575-3445.
- Hacker, M. & Barden, R. (1993). *Living With Technology*. Albany, NY: Delmar Publishing Company.
- Potter, T. & Guld, I. (1983). *Robotics*. Usborne New Technology Series. London, UK: Usborne. pp. 18-19.
- Schmitt, N. M. & Farwell, R. F. (1984). *Understanding Automation Systems*. Dallas, TX: Texas Instruments. ISBN#0-02-677020-2, pp.
- Todd, R.; McCrory, D., & Todd, K. (1985). *Understanding and Using Technology*. Worcester, MA: Davis. ISBN#087192-165-0, pp.
- Wright, R.T. (1985). *Exploring Manufacturing*. IL. Goodheart-Wilcox.
- Wright, R.T. & Henak, R.M. (1985). *Exploring Production*. IL. Goodheart-Wilcox.

Films/Slides/Video

Film, select an appropriate item from the Society of Manufacturing Engineers, National Bureau of Standards, or other media sources per section III, part 4.

A. Film, "Race Against Time."

B. Film, "AIT Production video tape."

A guest lecturer from any mass production environment. Consider factories and manufacturer home plants near you and a guest lecturer who will deal with an overview of manufacturing automation. If this is not possible, contact the National Bureau of Standards in Gaithersburg, Maryland for a list of videotapes on the topics.

Filmstrip - Manufacturing: People, Processes and Products. The Singer Company, Education Division, Career Systems, 80 Commerce Drive, Rochester, NY 14623.



Magazines

Tech Directions/School Shop

Technology Innovation Entrepreneurs Students (TIES)

Workbench

Fine Woodworker

Popular Science

Society of Plastics Engineers

Missouri Introduction to Materials and Processing Technology Guide

Missouri Introduction to Industrial Technology Guide

Software

GENIC - NC simulation software from MORETECH (for Activity #3)

Suppliers:

Fischer Technik
Fischer America Inc.
1904 Oostburg Court
Modesto, CA 95356
(209)575-3445

Legn Systems Inc.
Educational Department
555 Taylor Road
Enfield, CN 06082
(800)243-4870

Glossary of Terms

Assembly Line - a manufacturing method in which each worker or machine does only a small part of the whole job, and the products being built move from worker to worker or machine to machine.

Automation - the operation of machines without direct human control: machines are controlling machines.

Business Plan - a written plan that states the goals and objectives of a business, the strategies and methods to be used to achieve them, and the financial requirements of that business.

CAD - Computer Aided Design. The use of a computer to assist in the process of designing a part, circuit, building, etc. Computer Aided Drafting. The use of a computer to assist in the process of creating, storing, retrieving, modifying, and plotting a technical drawing.

CAD/CAM - a technology that links computer-aided design with computer aided manufacturing. Design information is communicated directly to the machine tool by computers.

CAM - Computer Aided Manufacturing, the use of a computer to control the manufacturing process.

CIM - Computer Integrated Manufacturing. The use of computers to control both the business and production aspects of a manufacturing facility.

Custom Made - products that are specifically produced to meet an individual's specified need.

Custom Manufacturing - production activity that yields a unique or highly individualistic product, e.g., luxury homes, limousines, built in furniture, etc.

Cybernetics - the intelligent control of machines by computers.

Entrepreneur - a person who forms and runs a business that is often based on new ideas and or inventions.

Fabrication - the making of things.

Fixture - a setup on a machine used to make multiple parts.

Flow Chart - a diagrammed sequence of the steps involved in the production line.

Robot - a programmable, multifunctional manipulator designed to move material parts, tools, specialized devices through variable programmed motions for the performance of a variety of tasks.

Interface - the bridge between two parts of a system. For example, an optical sensor interfaces to a controlling computer to tell it whether or not there is a part waiting to be picked up.

Jig - a device for holding material during assembly.

Lay up - the process of saturating glass cloth or mat with plastic resin.

Manufacturing - a process of making products.

Mass Production - producing large quantities of identical products in a short time.

Production - the system used to make products. Products can be made in a factory or workshop or on site.

Prototype - a model of the final product to help evaluate its design and to discover problems that may exist in production.

Quality Control - making sure the quality remains high during the production run.

Simulation - the representation of something by means of a game or model, often on a computer.

Transfer Line - a manufacturing system in which individual stations are indirectly connected together by means of a conveyor system.

Unit Cost - the cost of each product.

Safety Factors

- Wear safety glasses when in the lab or when operating equipment.
- Use common sense around all equipment.
- Follow specific safety rules regarding the use of equipment.
- Insure that all students have been taught basic hand tool and machine operation.
- Test all students on all machines and operations to ensure they are competent and safe.
- Instructors must always reinforce the importance of safety.
- Because of the toxic fumes of many resins and solvents be sure to have superior ventilation and respirators with an appropriate filter cartridge!
- Guard against fires by not having any open flames in the same laboratory when solvents, resins or fiberglass is present.



Instructional Suggestions

Motivation

- Video materials about mass production and manufacturing/ automated manufacturing activities.
- Post pictures and posters of high-tech manufactured materials and equipment on the walls.
- Arrange for guest speakers to describe state of the art manufacturing equipment.
- Conduct field trips to local manufacturing facilities.
- Alert students to trade shows and expositions pertaining to technology.
- Display samples of mass produced products around the school and in the community.
- Video tape production, use of computers is a plus, invite administrators, counselors, news coverage can all be used to heighten the motivation.

Prerequisite Information

- Students must have experience with machine tools and their operations maintaining the highest safety standards at all times.
- Some basic knowledge of factory components and mechanical systems such as gears, cams, jigs and fixtures would be helpful.

Demonstrations

- Examples of bill of materials, flow chart, plan of procedure, tips on video taping activity.
- Interface classroom activities to the computer, such as spread sheets, CAD, CIM, CAM, graphics, etc..
- Safety and tool operation.
- Jig and fixture building.
- Mechanical drafting and computer applications.
- Power supplies and the connection of electronic components (meters, etc.) such as the Fischer Technik and LEGO Technic series.
- Interfacing computer to models.
- Use of camcorder.
- How to set up an assembly line.
- Cutting operations and use of equipment.
- Mixing resin, pigment and catalyst.
- The lay-up process and clean up process when working with fiberglass and chemical ingredients.

Academic Enrichment

- Involve the business education department in developing and operating the business plan for the manufacturing operation.
- Involve the Fine Arts department in designing a company logo.
- Involve the language arts department in making certain that the entire manufactur-



ing operation is appropriately and correctly documented.

- This TAM provides an excellent opportunity to reinforce basic skills in math, drafting, communications, typing, and problem solving.
- Include some focus on the increasing use of composite materials and newer fibers such as carbon and kevlar.

Related TAMS

- Introduction to Materials & Processing Guide
 - TAM 9 Jigs and Fixtures
 - TAM 10 Automated Manufacturing
 - TAM 12 Mass Production
- 1991 Implementation Workshop TAMS
 - TAM 3 Manufactured Car Activity

Assessment/Evaluation Suggestions

- Evaluate the projects design/ sketch based on the design principles of form, function and ease of manufacturing.
- Consider pre-test and post-test results in addition to the rating of the students final projects taken by the student.

Note: Review the assessment items which are presented throughout the Performance Standards TAMS for ideas which can be adapted for this TAM. You should also refer to the Performance Standards Implementation Handbook for additional assessment examples and ideas.

Summary

In this activity students were introduced to mass production and manufacturing/ automated manufacturing activities. Review the steps in the mass production process and summarize the key variables in the cost effectiveness, time management, marketing, and production efficiency. Highlight factors relevant to business, industry, and the social impact of technology. The following should be reviewed before completing this module.

- How and why is the class mass production activity different than what occurs in real life? Scale, Capitalization, Quantity, Human resources, Risk factors, etc.
- What trends are emerging in the technological arena most closely related to the mass production activity? CIM/CAD/CAM, Flexible Manufacturing (FMS), flat organizational designs, etc.
- Review the importance of problem solving, planning, organization, quality control, and review advantages, planning, organization, quality control, and disadvantages, waste, relate to large industry.



Structures that Work

Goal

In this activity the students will use bridge building as a vehicle for learning the design process and applying key engineering considerations such as strength to weight ratios. The activity will also compare designs and materials using destructive testing techniques.



Mathematics



Communications



Science



Social Studies



Fine Arts



Health



Technology

Performance Standards

- Identify typical applications in which the theories of bridge building construction are effectively used in other industries.
- Speculate the future of various areas of bridge building, including space-age materials, truss designs, and construction techniques.
- Recognize and analyze the potential positive and negative impacts of the increased use of bridges/support structures on students, their future employment, and society.
- Discuss the role which aesthetics has played in bridge construction throughout history.
- Define those theories, practices and terms used in bridge building, including strengths of materials, trusses, spans, camber, dead loads, and live loads.
- Develop a design for and solve problems related to constructing a load-bearing bridge, including mathematical computations.
- Identify and describe methods for conducting non-destructive tests on bridge structures.
- Communicate orally, visually, and/or in writing the principles of constructing a load-bearing bridge.
- Demonstrate proper care and safe handling of project-related equipment.
- Practice all safety procedures when constructing a bridge and when using the tools associated with constructing and testing a bridge.
- Identify and describe basic bridges.
- Identify the various foundation skills for different career options in the designing, construction, and structural analysis of bridges and related structures.



Introduction

Since the beginning of time people have been confronted with the problem of getting across natural obstacles such as rivers, cliffs, and lakes. We still confront these obstacles. Modern bridges are superbly built and constructed through knowledge, imagination, and ingenuity of designers, engineers, and technicians. The selection of materials and designs vary according to criteria such as cost, function, location, and aesthetic considerations.

In this TAM's activities you will research, design, and build various types of bridges using different materials. You will then test these different designs to see which ones are the most durable.

This revised TAM (from TAM #6 - Materials and Processing Technology Guide) will move through the following sequence:

- Design and construction of a bridge from an alternate material (In this case metal).
- Testing using both destructive and non-destructive procedures.
- Calculating efficiency ratings.

Objective Statement

The activities described in the following pages represent samples of activities which can be used to deliver the performance standards on page 1. Many additional activities can and should be used. Extreme care should be taken to connect each activity with appropriate activity objectives as well as with the performance standards. These objectives should be developed by the instructor and should be shared with and made clear to the students.



Integrated Activity Idea

Do a research report (verbal or oral) on the 3 tallest towers in the world. What are they? How are they different in terms of style, materials, and construction techniques used, etc.?



Integrated Activity Idea

Write a descriptive paper explaining the procedure to be used for construction and why selected techniques were used. Use an English department rubric to help evaluate the activity.



Integrated Activity Idea

Prepare a technical report detailing the problem, the solutions considered, the one chosen, and the reasons for choosing the solution.

Activity 1

Bridge Design and Construction

This activity will build on the process which is outlined on pages 5-9 of TAM #6-Bridge Construction in the Introduction to Materials and Processing Technology Guide. It is important to remember that, in addition to the fun and challenge involved in designing, making, and testing the bridge, that the primary purpose of this TAM is to explore the nature of materials and structures. So, the principles learned through these activities will apply equally as to other structures such as buildings, automobile frames and bodies, all kinds of containers, aircraft design and lots more. Be thinking about the possibilities and let's begin.

Procedure

The first activity consists of three bridge design activities which could be used as "start ups" for the unit in structures. (Note: all of these activities are either currently being used or are being considered as events for the state's EXPO contest).

Start-Up Activity 1 - Spaghetti Tower

- This activity consists of designing and constructing a tower out of spaghetti, marshmallows, and masking tape. The challenge consists of maximizing height at a minimum cost.
- Angular joints between spaghetti sticks are made with marshmallows.
- Costs are to be computed according to the following guidelines.
 - ◆ Beams (sticks of spaghetti of any length, including those taped together at any angle) cost \$500.00/beam.
 - ◆ Marshmallows cost \$300.00 each.
 - ◆ Masking tape costs \$100.00 each.

Procedure

1. Divide students into groups of 3.
2. Have them develop sketches of their design.
3. Obtain a patent license from the instructor prior to "purchasing" materials (basically, this is an instructor check to make certain that students have given some thought into their designs prior to beginning construction).



4. Secure spaghetti, marshmallows, and tape from instructor.
5. Construct the tower. Construction time is limited to 10 minutes and a tower must remain standing to be eligible for competition.

6. Compute the cost per inch for the tower.

$$\text{Cost/Inches} = \frac{\text{Total Cost of Materials}}{\text{Height of Tower In Inches}}$$

7. Debrief the experience with students using the following:

- What designs worked best? Why?
- What kinds of configurations made the structure most stable?
- What kinds of designs did not work? Why?
- What did the results teach you about strength and materials cost?
- Think of some real world illustrations of where "overdesign" proved too costly.
- Think of an example where "cost cutting" led to poor design.

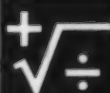
Materials Needed

spaghetti
masking tape
marshmallows
measuring tape
paper for designing sketches
pencils



Integrated Activity Idea

Use vector analysis to analyze the forces of various triangular shapes as well as truss configuration.



Integrated Activity Idea

Determine the area and circumference of selected triangles and suggest if a relationship exists between these elements and strength.



Integrated Activity Idea

Note geometric designs and patterns and their aesthetic value. Which are the most appealing? Why?



Technology Idea

Compare a selection of materials for strength: glass, sheet metal, wood, plywood, paper, etc. Have students "vote" on which material they think is strongest. Then discuss their reasoning. The discussion should focus on different types of strength, including torsional, shear, bending, compression, compact and tensile.

Start-Up Activity 2 - Newspaper Bridge

This activity consists of constructing a bridge out of a single folded out sheet of newspaper and 20" of masking tape. The bridge will be restricted to the following guidelines:

- 5" maximum width
- 2-1/2" minimum height
- 16" minimum length (span)

The challenge is to design and construct a bridge that will span the longest distance within the guidelines provided above. The class can be divided into teams to design and build the bridge. This can be set up as a design competition where the bridge spanning the greatest distance wins!

Procedure

1. Divide the class into small groups.
2. Have the students sketch a design.
3. Construct the bridge.
4. Compare the bridge with the guidelines established to make certain the criteria qualify the bridge for "competition."
5. Determine the contest winner based on the longest distance spanned.
6. As a class, analyze the various designs.
 - What design configuration was the strongest and why?
 - What is the relationship between "flimsy" materials and strength?
 - Think of some real world examples where light weight materials are designed to make strong structures (for example: auto bodies from thin sheet metal).



Integrated Activity Idea

The debriefing session at the end of each activity is important. Learning theory points out how important reflection is for making connections with previous knowledge and recognizing relationships. Use the questions stated in #7. Debriefing should be individual and group based, oral and/or written.

Materials Needed

Newspaper
Masking tape



Start-Up Activity 3 - Edible Bridges

A third start-up activity idea consists of a contest where a bridge is designed and constructed from edible materials. Possible materials could include carrots, celery, pretzel sticks, gum, chewy fruits, crackers.

Procedure

1. Establish guidelines (maximum width, time limit, length, etc.).
2. Design and construct the bridge.
3. Test the bridge for load (destructive testing).
4. Make a listing of all materials used in all designs.
5. As a class discuss the strength characteristics of each material (for example, carrots are stiff, but break when bent).
6. Apply the information about the various types of strengths of the materials to the destructive tests which were conducted on the bridges.
7. Develop a chart on which to record the various materials and the types of strength (bending, compressive, impact, torsional, etc.). Develop a testing method which will allow you to accurately compare the tests between materials.
8. Which materials and which configuration yielded the strongest bridges? Why?



Integrated Activity Idea

Select one of the famous bridges in the world and prepare a case study. Include information such as background of designer, special design features, materials, ties with local architecture, cost, etc.

Materials Needed

Edible materials as selected

Activity 2

Wood Truss Bridge Design & Construction

This activity will involve the design and construction of a truss bridge from wood. Prior to beginning work, review TAM #6 of the (M&P) guide. Design of the bridge structure should then begin using the following design parameters (based on Missouri's EXPO guidelines).



Integrated Activity Idea

Prepare a photographic display depicting particularly interesting structures from your local area. These need not be bridges. Include a written description of the features, highlighting their unique form or function values.

- 15 maximum- 3/32" x 3/32" x 24" basswood or balsa wood sticks (available from most technology education suppliers).
- No lamination of wood sticks to each other (along their lengths).
- The bridge must be symmetrical.
- Roadway thickness - 20 mm maximum.
- The bridge must have a superstructure (a supporting structure above the bridge floor).
- The bridge must not have a substructure (no part of the structure may exist between the bridge support or grade).
- Minimum of 50 mm wide.
- Length 250 mm minimum and 300 mm maximum.

Procedure

1. Break the class up into groups of two students to develop designs.
2. Each pair should develop a minimum of three design solutions using sketches.
3. Select one design, recording the reasons why it was selected.
4. Prepare a detailed drawing of the design using a CAD system if available. (Note: you may wish to turn to Activity #5 in this TAM which uses a finite element analysis computer program to test a model design prior to construction).
5. Using the procedures outlined in TAM #6, Materials and Processes, construct the bridge.
6. After constructing the bridge, test it as indicated in TAM #6, activity step #13. (Additional enhancements to the testing process could include using a photographic strobe trigger to record the instant of collapse. The collapse could also be recorded using a camcorder. These methods would assist in analyzing precisely what component failed, thus contributing to the understanding of structural design).



7. Calculate the weight efficiency of the design as outlined in step #17 of TAM #6 of the (M&P) guide.
8. Describe the results as a class.
 - What design features contributed to overall bridge strength? Why?
 - What were the weak points? Why?
 - What could have been changed to improve the design? Why?
 - What design features, if any, did not seem to either enhance or detract from the bridge's strength? Why?
 - How do the destructive and non-destructive results of finite element analysis compare? Why?
 - If they were different, why?
9. Prepare a technical report, documenting your results.



Technology Idea

Adapt the laser deflectometer, which is described in TAM 15 - Materials and Processes, for use in measuring the amount of deflection in the bridge while testing.

Materials Needed

Supplies

Drawing Paper
Graph paper
Glue (white) or hot-melt adhesive
#2 pencils
Pre-cut wood (balsa, pine or basswood strips; straws)
Straight pins
Sand or lead shot for loading the bridge
Cardboard
Utility knife and blade
Brushes
Paints
Chart (large) to show results of each tested bridge

Equipment

Universal testing machine, or
Hydraulic jack with pressure gauge, or
Self-made bridge loading system, pail
Testing fixtures (bridge positioning jigs)
Bathroom scales for weighing loads
Safety glasses
Duplicating machine/blueprints
Drafting instruments
Modeling knives
Hot-glue gun

Activity 3

Metal Bridge Design & Construction



Integrated Activity Idea

Enhance the bridge's appearance in some way by painting, or some other method. How is appearance typically enhanced in "real live" bridges?

One of the most challenging aspects of structural design has to do with matching design criteria with a wide variety of materials. Design criteria could include:

- appearance
- strength
- durability
- cost
- weight, etc.

A key design decision has to do with selecting the material (or combination of materials) which most appropriately meets the design priorities. (For example, furniture should generally be durable, reasonably priced, and attractive. Combinations of wood, processed wood, plastics, and fabric are used to meet these criteria).

This activity will extend Activity 2 to another material; in this case, metal. The procedure will consist of duplicating as closely as possible the design which was previously constructed from wood. You will then compare the results using destructive testing.



Technology Idea

Develop a drawbridge design for the metal bridge. Incorporate a working gear mechanism to raise and lower the bridge on command using different power systems (hydraulic, mechanical, electric). See TAM 9 - Robotics for additional ideas.

Procedure

1. Working in the same pairs as for Activity 2, develop a predictive analysis of the anticipated test results of the metal bridge (constructed to identical design specifications as the wood truss bridge).
 2. If the finite element analysis computer program has been obtained (see activity # 5), analyze the metal material model and compare the results to the wood material model.
 3. Secure a maximum of 15-1/8" dia. x 24" brass welding rods.
 4. Cut to length using a bandsaw or hacksaw.
 5. Sand or file the ends as necessary for joint fit.
- Instructor's Initials**
6. Solder the joints using an acid core solder (40/60) and a soldering iron.

Note: Make certain all joints are secure (the solder has flown into the joints and has adhered securely to the brass rod).



7. After the bridge has been constructed, test it using the same procedures described in activity #2. Since metal is being used, the bridge failure criteria must be adjusted (since the structure will likely not collapse). The bridge will have been considered to be failed when its unloaded downward deflection is no more than $1/4"$. (This is measured by calculating the difference between the unloaded bridge floor level prior to testing and the unloading floor level after testing).
8. Calculate the weight efficiency index for the metal bridge.
9. Include a discussion of the following points in a technical report.
 - Which material (wood or metal) proved to be superior using the selected design? Why?
 - How should the design be altered to make it more efficient for metal?
 - How did the results of the destructive test compare with the finite element analysis model of predictions?
 - Think of 2-3 real world examples of structures which illustrate the principles learned in activities #2 and #3.

Materials Needed

15-1/8" dia. brass welding rods
Acid core solder
Coarse steel wool (or finishing scuff pad)
Equipment
Hacksaw
File
Power sander or grinder
Soldering iron

Activity 4



Technology Idea

Use a laser to measure the bridge's deflection. See TAM 15 -Materials and Processing, Activity 6.

Suspension Bridge Design & Construction

The previous two activities were designed to compare one selected design by using two different materials. When materials perform equally well on one criterion (such as strength) then other criteria are used for selecting the material to be used. This may include cost, appearance, etc.

Another way of comparing structures is to compare two or more different designs using similar or identical materials. This is the approach which will be used in this activity. The material will stay the same (either wood or metal. The main changes made during this will be in terms of design rather than material. You will design, construct, and test a suspension bridge as a modification of either the wood or metal bridge.

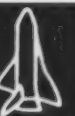


Technology Idea

Adapt the polarizing procedure described in the (M&P) Guide (TAM 5 - Activity 2) for use as a non-destructive testing device for bridges.

Procedure

1. Break the class into groups of 2-3 students. Assign them a discovery (research) activity consisting of locating examples of suspension bridges. Sources may include encyclopedias, engineering textbooks, popular magazines, photos of a bridge in the local area, etc.
2. After the various designs have been collected, conduct a class brainstorming discussion. Identify the features common to all (or most) of the example bridges.
3. Have each of the small groups (design teams) prioritize the brainstormed list in order of importance (of the various design characteristics). These criteria will be the ones they will be expected to incorporate into their team's design. (Note: at this point in the process, make certain students record their priorities and that they include the reasons for their priorities). This information will be incorporated into their technical report at the end of the activity.
4. After the design criteria have been prioritized, develop the suspension bridge design which incorporates the top two design features identified by the small group. In addition to these criteria, use the restrictions outlined in either activity 2 or 3 (for either the wood or metal bridge, such as maximum thickness of the roadway bed, maximum/minimum overall length, etc.). The major change will be that the rigid superstructure must be replaced with a suspension structure.
5. Develop the initial design sketches into a working drawing using CAD (or mechanical drawing tools). The design must include a specification of the material to be used for the superstructure. (Possibilities include



Technology Idea

An example of a structure which did not work is the Tacoma Narrows bridge in Washington state. Obtain, watch and then discuss the video which shows the bridge's collapse (available on laser disk as part of the Technology series by Thode and Thode).



nylon fishing wire, thread, small gauge wire, etc.). They must also include the method of attachment of the suspension materials to the rest of the bridge structure. Record the rationale for the choices which are made (strength, cost, availability, etc.).

Instructor's Initials

6. Construct the suspension bridge design.
7. After the bridges have been constructed predict and record how the suspension bridge designs will compare to the truss bridge designs (wood or metal as appropriate) in a destructive test. Predict both the anticipated load failure and the weight efficiency.
8. Conduct the destructive test and record the results.
9. Calculate and record the weight efficiency.
10. Compare the destructive tests of the truss and suspension designs using the following focus questions:
 - Which design proved to be superior? Why?
 - How could the design of the weaker bridge have been changed to improve its performance?
 - After these improvements, could this bridge have outperformed the other bridge? Why or why not?
 - What are the advantages and disadvantages of the two different designs?
 - Cite some examples of other structures where these design features have been used. Include the reasons for their use.

Materials Needed

Thread, wire, string, etc. for use as suspension material.

Same materials list as for either wood design (activity #2) or metal design (activity #3).



Technology Idea

View and discuss the video showing the construction of the St. Louis Gateway Arch.



Technology Idea

Go to a lumber yard, or a truss-designer or builder. Have them describe the advantages and disadvantages of different styles of trusses used in residential or commercial construction. Ask this person(s) for ideas in how to improve your bridge design.



Technology Idea

Add a roadway surface to your bridge. Experiment with different materials such as wood, asphalt, cement, etc. Discuss the relative advantages and disadvantages of each material.

Activity 5

Finite Element Analysis



Technology Idea

Name some situations or examples where computer modeling procedures are used whether for design, testing, or prototyping purposes?

Wouldn't it be great to be able to test a design non-destructively, without needing to destroy the bridge in order to find out how strong it is? In the "real world" it would make no sense to break everything that's built just to see how strong it "was". These procedures, called NDT (or non-destructive testing), are used extensively in industry today. In fact, the rapid advance of powerful computing technologies have made it possible to pre-test designs prior to prototyping or construction. These are called computer models.

A specialized form of computerized modeling which has gained wide use for structural testing is called FEA (finite element analysis). These computer programs provide a means of testing models in graphic form prior to actual construction to identify potential failure points. They enable engineers and designers to explore structural performance using different materials, examine alternative designs, etc. Engineers and designers routinely use FEA as tools in the design process.

This activity will provide basic information on how to locate and access a basic FEA computer software package. Basic information about the program will be included.

Basic description of the GBEAM FEA software package:

- GBEAM is a DOS based "CAD-like" program which allows the designer to develop a design on screen.
- Materials from which the structure will be constructed can be specified.
- The stress (or load point) or points can be identified.
- Minimum and maximum load values can be specified.
- The on-screen output will show (through change of color) the stress which will occur along the structure.
- The point of failure will also be shown on screen.

Additional features include four demonstration animations:

- A bicycle frame
- A chair
- A truss
- A bridge



Technology Idea

Do a finite element analysis of parts of your school, such as the beams in the gymnasium, lunchroom, etc.



Procedure

1. Access Moretech (Note: the program GBEAM v2.0 has been loaded onto the Moretech system. To locate the program, send an E-mail message to ldiel@services.dese.state.mo.us. A message will be returned informing you of the program's location on the system as well as any specific downloading information. The reader should also refer to TAM # 3-Telecommunications/Telephony-Activity #3 for additional information on accessing and downloading programs from the Moretech system).
2. Download the program to your computer.
3. Unzip the package. (Instructions will be included on the system which will assist you in doing so).
4. Print out the readme file which includes a ten page manual including a specific step by step tutorial example.
5. Execute the program and complete the three tutorial examples.
6. Use the program to examine the designs developed in activities 2-4 of this TAM.



Technology Idea

Make a bar graph which depicts the test results of the various designs and materials.

Materials Needed

IBM compatible computer (XT, AT, 386, 486)
DOS 3.0 or Higher, or windows 3.1
640K Ram
CGA, Hercules, EGA, VGA, ATT
Hard disk recommended
Math coprocessor (recommended, but optional)
Mouse (recommended, but optional)

Assessment

Scoring Rubric for Activity 4 - Suspension Bridge Design & Construction

Performance Standard	Wgt %	Exemplary 2 pts.	Acceptable 1 pt.	Not Yet Acceptable 0 pts.	Sub total
I. Creative Thinker					
Identify typical applications in which the theories of bridge construction are effectively used in other industries.	x.25	Student correctly identifies 3 additional structures that incorporate suspension bridge theories.	Student correctly identifies 1 additional structure that incorporates suspension bridge theories.	Student does not identify any additional structures that incorporate suspension bridge theories.	2x.25 = .5
Speculate the future of various areas of bridge building, including space age materials, truss designs & construction techniques.	x.25	Student lists three materials that may be used for suspension materials.	Student list one material that may be used for suspension material.	Student lists no materials that may be used for suspension material.	2x.25 = .5
II. Critical Thinker					
Recognize and analyze the potential positive and negative impacts of the increased use of bridges/support structures on students, their future employment, and society.	x.5	Design Team recognizes and analyzes 3 each potential positive and negative impacts of the increased use of suspension bridges.	Design team recognizes and analyzes 1 each potential positive and negative impacts of the increased use of suspension bridges.	Design team does not recognize and analyze any potential positive or negative impacts of the increased use of suspension bridges.	2 x .5 = 1
III. Contributing Citizen					
Discuss the role which aesthetics has played in bridge construction throughout history.	x.25	Student Groups (per Proc. 1) complete research project with no errors.	Groups (per procedure 1) complete research project with 2 or fewer errors.	Groups (per Procedure 1) complete research project with more than 2 errors.	2x.25 = .5
IV. Self-Directed Learner					
Define those theories, practices and terms used in bridge building, including strengths of materials, trusses, spans, camber, dead loads, and live loads.	x1	Student correctly defines Suspension theories, practices, and terms with no errors.	Student defines suspension theories, practices, and terms with 2 or fewer errors.	Student defines suspension theories, practices, and terms with more than 2 errors.	2 x 1 = 2
V. Problem Solver					
Develop a design for and solve problems related to constructing a load-bearing bridge, including mathematical computations.	x2	Team's suspension design meets all criteria as set by the groups and teacher.	Team's suspension design meets 70% of criteria as set by the groups and teacher.	Team's suspension design does not meet at least 70% of criteria as set by the groups/ teacher.	2 x 2 = 4
Identify and describe methods for conducting destructive and non-destructive tests on bridge structures.	x1	Student successfully describes tests on suspension bridge with no teacher assistance.	Student successfully describes test on bridge with limited teacher assistance (lower than 2 times).	Student does not successfully describe test or requires constant teacher assistance.	2 x 1 = 2
VI. Effective Communicator					
Communicate orally, visually, and/or in writing the principles of constructing a load-bearing bridge.	x1	Student submits a technical memo describing the principles with no errors.	Student submits a technical memo describing the principles with less than 3 errors.	Student submits a technical memo describing the principles with 3 or more errors.	2 x 1 = 2
VII. Quality Producer					
Demonstrate proper care and safe handling of project-related equipment.	x1	Student shows proper care / safe handling at all times regardless of supervision level.	Student shows proper care / safe handling at all times with direct teacher supervision.	Student does not show proper care / safe handling at all times regardless of supervision level.	2 x 1 = 2
Practice all safety procedures when constructing a bridge and when using the tools associated with constructing and testing a bridge.	x2	Student constructs and tests bridge with no safety incidents with no additional teacher supervision.	Student constructs and tests bridge with no safety incidents with additional teacher supervision.	Student constructs and tests bridge with safety incidents or accidents regardless of supervision.	2 x 2 = 4
VIII. Technical Foundations					
Identify and describe the basic types of bridges.	x.5	Student describes basic types of bridges with no errors.	Student describes basic types of bridges with 2 errors.	Student describes basic types of bridges with more than 3 errors.	2 x .5 = 1
Identify the various foundation skills for different career options in the designing, construction, and structural analysis of bridges and related structures.	x.25	Student identifies three foundation skills for different career options in the bridge building area.	Student identifies one foundation skill for different career options in the bridge building area.	Student does not identify any foundation skill for different career options in the bridge building area.	2x.25 = .5

Total: 20 out of 20 Possible



Check List for Use with Activities 2-4

- 4 = Excellent (student successfully completes activity & displays mastery of subject/content)**
3 = Good (student completes activity with good quality)
2 = Needs Improvement (student completes activity without demonstrating mastery of subject matter or activity performance requirements)
1 = Not Acceptable (student does not yet successfully complete the activity, needs additional work)

	4	3	2	1
1. Develop preliminary Ideas and then convert them into a sketch	☐	☐	☐	☐
2. Rationale for design selection	☐	☐	☐	☐
3. Quality of working drawings				
4. Overall quality of bridge construction	☐	☐	☐	☐
5. Affective skills (concern for quality, on task, group membership)	☐	☐	☐	☐
6. Quality of documentation	☐	☐	☐	☐

Performance Checklist for Activity 5 - FEA

1. Student demonstrates proper use of computer, including boot-up sequence.	4	3	2	1
2. Student correctly and efficiently accesses MORETECH for software download.	4	3	2	1
3. Student correctly and efficiently downloads GBEAM software.	4	3	2	1
4. Student correctly uncompresses software, including placing GBEAM in proper directory/folder.	4	3	2	1
5. Student correctly prints of the manual/tutorial examples from the readme file.	4	3	2	1
6. Student correctly executes the program.	4	3	2	1
7. Student correctly and efficiently maneuvers with GBEAM.	4	3	2	1
8. Student successfully completes the three tutorial programs.	4	3	2	1
9. Student correctly and efficiently transfers knowledge gained in tutorials to designs developed in Activities 2-4 of this TAM.	4	3	2	1



By Joe Scarcella & Rod Custer

Instructor Resource

Structures that work

Content Outline

1. Bridge Configurations

- Truss
- Suspension
- Arch
- Flat
- Girdered

2. Design Factors

- Aesthetics
- Strength
- Use
- Materials

3. Structural Analysis

- Design
 - ◆ force analysis
 - ◆ load analysis
 - ◆ strength analysis
- Non Destructive Testing
 - ◆ computer modeling (NDT)
 - ◆ X-ray
- Destructive Testing

4. Other Structures

- Trusses
- Large Span Structures
- Residential Homes
- Commercial Structures
- Prefabricated Structures

Instructional Resources

Books

- Betts, M.R.; Hauenstein, A.F. & Fannin, J.W. (1976). Exploring the Construction Industry. Bloomington, IL: McKnight.
- Daniel, C. (1986). Roof Truss Strength Test. CITE Module. Munice, IN: Ball State University, pp. 1-10.
- Darrow, D & Pine, D. (1980). Production Systems. Des Moines, IA: Department of Public Instructions. pp. 205-214.
- Fales, J.F.; Kuetemeyer, V.F. & Brusic, S.D. (1988). Technology Today and Tomorrow. CA: Glencoe. ISBN 0-02067020-2, pp. 366-369.
- Gray, G. (1986). Construction Trusses. CITE Module CO-W-014. Munice, IN: Ball State University. pp. 1-8.
- Gemmill, L. (1987). Truss Stiffness Testing-Torsion. CITE Module CO-P-019. Munice, IN: Ball State University.
- Goetsch, D.L. & Nelson, J.A. (1987). Technology and You. Albany, NY: Delmar. ISBN 0-8273-262-9. pp. 79-110.
- Lux, D.G. & Ray, W.E. (1970). The World of Construction. Teacher guide. Bloomington, IL: McKnight. ISBN 87345-465-0. p. 219.
- Midwest Products Company. (1986). Teaching with Model Bridge Building Programs. Detailed activity module. Hobart, IN: Midwest Products Co., 400 S. Indiana Street, P.O. Box 564, Hobart, IN 46342.
- Wood, J. (1987). Exploring Construction Technology. Stillwater, OK: Mid-America Vocational Curriculum Consortium.
- Building Toothpick Bridges. Available from Pitsco.

Film Slides/Film/Video

1. A short film on bridge construction, e.g., The building of the Arch or alternatively, the bridge building video available from the National Bridge Building Contest, c/o Mr. Arnold Bukert, 5750 S. Austin Ave., Chicago, IL 60638, (312)581-0378.
2. Field trip to an actual bridge to identify components and design features.



Magazines

TIES

Tech Directions

The Technology Teacher

Software

GBEAM v2.0-available on MORETECH

Glossary of Terms

Beam - A form of bridge, but usually it is much simpler in construction. A tree over a stream is the most basic form.

Bridge - An assembly of components that spans the gap between two or more abutments and supports a load while doing so.

Compression - The opposite of tension. Compression occurs when a material is being pushed together.

Creativity - The generation of new ideas or the application of ideas to new ends.

Joints - The place of intersection where bridge components are joined to one another.

Load Bearing - Holding the weight or other forces.

Member - A component of a bridge truss.

Span - The distance between bridge supports.

Substructure - Structure of a bridge which extends below the roadbed.

Superstructure - The structure which extends above the roadbed.

Tension - The opposite of compression. Tension occurs when materials are being pulled apart.

Test Sling - The device used to apply load to the bridge/truss in laboratory testing.

Truss - A set of linked pieces that together distribute applied loads to where ever they can be best handled.

Truss Strength - The amount of load a truss can hold before it breaks or deforms too much.

Truss deflection - The result of stiffness. The amount the bridge/truss deflects when loaded.

Safety Factors

- Although only simple precautions must be observed when handling model building tools and materials, it is good practice to reinforce safety at all times.
- Explain the proper use of modeling knives and hot glue guns for example.
- Always cut away from your body and hands.
- Never move about the laboratory with a knife in an exposed position.
- Avoid touching hot melt adhesive.
- These are but a sample of basic safety considerations to be highlighted.
- Keep feet and hands clear of the area under the bridge when load testing.
- Wear safety glasses when in lab.

- Use common sense around equipment.
- Follow specific safety rules regarding the use of equipment.
- Ensure that all students have been taught hand tool and machine operation.
- Test all students on all to ensure they are competent in the operation of equipment.
- Instructors must always reinforce the importance of safety.
- Guard against fires by not having any open flames in the same laboratory when solvents, or flammable products are present.

Instructional Suggestions

Motivation

- Perhaps the most powerful motivational suggestion is to incorporate a competitive aspect; within the class, across classes, or even across schools.
- The state-wide competition during the MITEA's annual Technology Exposition Contest is a further motivational factor.
- Video materials about bridge building activities.
- Post pictures and posters of high tech manufactured materials and equipment on the walls.
- Arrange for guest speakers who understand the design, manufacturing techniques, and engineering aspects associated with bridge building.
- Arrange for a field trip to local bridges in the community.
- Video tape production, use of computers is a plus, invite administrators, counselors, news coverage can all be used to heighten the motivation.

Prerequisite Information

- A general understanding of stress and strain is useful as is a basic knowledge of the nature of materials, joints, failures, etc.
- Students must have experience with machine tools and their operations maintaining the highest safety standards at all times.
- Some basic knowledge of construction be useful.

Demonstrations

- Safety and tool operation.
- Mechanical drafting and computer application.
- Interfacing computer to model.
- Interfacing classroom activities to the computer, such as spread sheets, CAD, CAM, CIM, graphics, etc.
- Use of camcorder.
- Cutting operations and use of equipment.
- Using the polariscope.
- Model building/ tool using techniques.
- Bridge testing (load).
- Truss testing (load).



Academic Enrichment

- Faster students should work out a vector analysis of their truss loads. They could get assistance from the physics instructors.
- Students could research designs and then do some preliminary design for their own bridges.
- A research and experimentation project on joint design could also prove to be valuable. Deciding upon the best type of adhesive is another project suitable for advanced students.
- Provide students with information pamphlets concerning bridge building techniques.
- Work in teams on computers (word processing and CAD) and the video equipment. Slower students should be teamed with the faster students.
- The ITE instructor should contact the students' other instructors and discuss how to jointly deal with integrating academics.
- This TAM provides an excellent opportunity to reinforce higher order skills of problem-solving and critical thinking.
- Experience the use of composite materials and material processes required for such an operation.

Related TAMS

- Introduction to Materials & Processing Technology Guide
 - TAM 5 Non-Destructive Testing
 - TAM 6 Bridge Construction
- 1990 Implementation Workshop TAMS
 - TAM 13 Simulated Materials Testing
- Standards Project TAMS
 - TAM 4 Graphic Communications/Specialized Photography
 - TAM 16 CAD

Assessment/Evaluation Suggestions

- Focus on the processes (design, construction, brainstorming, innovative ideas) involved in the activity.
- Spend time assessing the process involved in working in a group during the activities.
- Develop scoring rubrics for each of the TAM activities.
- Develop a bridge building portfolio. Expand it to a structural engineering portfolio.

Important Note: Review the assessment items which are presented throughout the Performance Standards TAMS for ideas which can be adapted for this TAM. You should also refer to the Performance Standards Education Implementation Handbook for additional assessment examples and ideas.

Summary

In this activity students were introduced to mass production bridge building. Each activity presented a different experience related to bridge design and construction.

Review the steps in the bridge construction process and summarize the variables in the cost effectiveness, tensile strengths, and design of your bridge. Highlight factors relevant to engineering, construction, and development. The following should be reviewed prior to completing this module.

1. How and why is this activity different from what occurs in real life? Scale, Cost, Efficiency, etc.?
2. Review the importance of problem solving, planning, organizing, design, and review the how they affect the construction process and the effectiveness of the bridge?
3. What steps in the bridge building process were the most difficult to design?
4. What methods could be used to test the structural integrity of the bridge?
5. Analyze and explain the outcomes of what happened before, during and after bridge design, assembly, and construction.



By Joe Scarcella & Rod Custer



Design in the Electronic Age

Goal

The purpose of this module is to introduce the basic commands and operations of a computer aided drafting (CAD) system at entry level for the first time user. Students will use the computer to generate drawings in place of the more "traditional" means (board/drafting machines).

**Mathematics****Communications****Science****Social Studies****Fine Arts****Health****Technology**

Performance Standards

- Identify typical applications in which CAD is effectively used in industry, such as drafting, designing, manufacturing, and material/design analysis.
- Identify and discuss typical industrial areas that use CAD, including architectural, mechanical, and process flow.
- Speculate the future of CAD, including its changing role in industry, hardware, and software innovations of the future.
- Discuss the advantages and disadvantages of CAD vs. "traditional" drafting methods.
- Practice all safety procedures when interacting with CAD and when using the output devices associated with CAD.
- Identify and use various CAD software packages across the major computer platforms (Macintosh, DOS-Compatible, Apple 2E).
- Develop a design for and solve problems related to a simple CAD project.
- Solve problems related to producing a CAD project, including software and hardware problems.
- Communicate orally, visually, and/or in writing the principles of a CAD system.
- Create a simple CAD project that is correct per ANSI-Y14a drafting standards.
- Define those practices and terms used in CAD software, such as basic drawing, editing, and manipulating, saving, and printing/plotting.
- Identify the various foundation skills for different career options in CAD.



Introduction

Computer aided drafting (CAD) is an innovation that has been developed to make drafting and its ties to manufacturing more productive. Just as T-squares, triangles, drafting machines, electric erasers, templates, reprographic drafting, etc. were tools that offered improvements, CAD is the newest innovation tool in the drafting field. An understanding of CAD basics will help you see one of the ways that design ideas are communicated between people. It will also demonstrate the various information encoding techniques and the storage and retrieval of information. In this module, you will use input and output devices, set drawing parameters, generate a simple drawing, edit an existing drawing, plot a drawing, and use generic system basics.

Objective Statement

The activities described in the following pages represent samples of activities which can be used to deliver the performance standards on page 1. Many additional activities can and should be used. Extreme care should be taken to connect each activity with appropriate activity objectives as well as with the performance standards. These objectives should be developed by the instructor and should be shared with and made clear to the students.

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Overview of the TAM Activity Sequence



Technology Idea

Investigate the skills and knowledge required to pursue a career in a CAD related field. Begin your investigation by identifying as many different types of businesses and companies as possible who use CAD systems. Select an individual (or several individuals) to interview about their work. Continue your information search by searching for CAD related information in the Dictionary of Occupational Titles (D.O.T.).

The activities in this TAM are designed to walk you through a series of experiences with CAD. You will find that each activity has been designed to build on the previous activity. For those who already have advanced knowledge of and experience with CAD, the first several activities will probably not be of much use. Just plug in at the level where you find the activities helpful.

This TAM has been specifically designed to help those who are interested in getting started with CAD. We'll begin with an activity which involves getting to know the variety of software that's out there. There's a lot of it and it's available for almost any platform. What's more, the quality and features have improved drastically while the costs of many packages have become quite reasonable (particularly for educational versions).

After we've explored the software package possibilities, we'll turn our attention to developing drawings. Activity 2 was designed to start you off with a step by step tutorial using a low cost and easily learned software program. You'll notice that there are 3 options: one for DOS machines, another for the Apple II series and yet another one for the Macintosh. You certainly don't need to do all three (unless you want to of course). The idea is to provide something for everyone, regardless of the type of machine you have in your classroom.

In Activity 3 we'll go on a "CAD scavenger hunt." This was designed to help you locate and document the commands and keystrokes needed to successfully develop CAD drawings and maximize the use of your software. You can use this exercise with any software package, from the simplest to those which are full blown and high powered. Then in Activities 4-6 you'll put the information to use creating (and figuring out how to create) drawings of your own. Have fun and remember, knowledge and skills in CAD are highly valued in a wide variety of professional careers!

Activity 1

Getting to Know the Software

The purpose of this activity is to help you become more familiar with the various software packages which are out there as well as the hardware systems requirements necessary to run them. At the outset it is important to note that this is tricky business since computers present "a moving target." The most certain way to cause a computer company to come out with a new model is to buy what's on the shelf today! So while the information in the tables may be relatively current as of today, you will need to constantly update your information and knowledge.



Procedure

1. Review the information which is presented in the tables. You will notice that some information has been provided and some has not. One of the purposes of this activity is for you to locate and obtain current software information. Also, you will probably not need to use all three depending on which type of computer system you have.
2. Prepare a letter to a number of Technology Education vendors requesting information about their company's CAD packages. Note, this would work well as a class project where different students could be in charge of writing various companies and exploring different platforms. The idea is to compile as much current information as possible about the available software. Note: You will also want to explore some mail order computer software suppliers.
3. Before beginning the contacts, spend some time as a class discussing how you would design a database to store the information. The tables on the next three pages are designed as samples to get you started. Think about the kind of information that you'd really like to have at your finger tips and then design that into the database.
4. Design and prepare a business correspondence (complete with any forms, requests, etc.) which you will need in order to obtain all of the information which you want to include in your "CAD Info" database.
5. As the information comes back, arrange for a way to enter and maintain the database. Note: this would be an excellent contribution to the MORETECH system. Your class could upload this for other students and teachers to access. Remember, information exchange is what MORETECH's all about!



Integrated Activity Idea

Design and incorporate a logo into the letterhead of the correspondence you do with CAD vendors. Share the contents of your letter and survey with other students and the computer science teacher (and students) to make certain it is accurate and complete. Remember, proof reading is important since we often fail to see our own mistakes.

Materials Needed

Computer software catalogues
Technology Education equipment and supplies catalogues
CAD and Communication Technology textbooks

DOS Compatible CAD Matrix

Program	Complexity			Math Coprocessor	EGA	VGA	8086	286	386 DX	486 DX	640 RAM	ext. mem.	Mouse	HD Space	Cost	Vendor
	Low	Med	High													
Microcad	✓			No			✓	✓	✓	✓	✓	✓	✓	2mb	\$49	
Cadkey 6 *			✓	Yes		✓	No		✓	✓	✓	4	✓	20 mb	\$250 ***	
Autocad 12 ⁺			✓	Yes		✓	No		✓	✓	✓	8*	✓	25 mb	\$3400	
Versacad			✓	Yes		✓	No	✓	✓	✓	✓	✓	✓			
Cadkey 7												8-16		25 mb	\$695 ***	
Generic Cad																
Auto sketch																
Cadkey light **		✓		α	✓		✓	✓	✓	✓	✓	α	✓	3 mb	FREE	
Turbocad																
Other																

- * Basic applications will run on 4mb if necessary
 ** Free site license for education labs. Contact CADKEY educational sales for more details.
 *** Special promotional through CADKEY
 α Not required but recommended by manufacturer

Note: Information subject to change - please verify



Apple II CAD Matrix

Program	Complexity			128 K ram	80 column card	2 drives	mouse	Vendor	Phone	Cost
	Low	Med	High							
Discover Cad	✓			✓	✓	✓	✓			
Mathcad		✓		✓	✓	✓	✓			
Apple Cad		✓		✓	✓					
Cad Draw		✓		64 kb		1 Dr.				\$129.95
Accudraw	✓			✓		1 Dr.	✓			\$99.95

NOTE: Due to changes in pricing and availability, it will be necessary for you to verify all information.

MAC CAD Matrix

Program	Complexity			Mac Plus	II series	SE	SE 30	Quadra	Power PC	Ram	Hard Disk Space	Vendor	Phone	Cost
	Low	Med	High											
Macdraft		✓		✓	✓	✓	✓	✓	✓	2				\$279
Design Cad 2D/3D			✓	✓	✓	✓	✓	✓	✓	2	4			\$175
Expert Draw	✓			✓	✓	✓	✓	✓	✓					\$29
Key Cad Complete	✓			✓	✓	✓	✓	✓	✓					\$50
Clariscad			✓	✓	✓	✓	✓	✓	✓	4	4			\$599
Genenc Cad		✓		✓	✓	✓	✓	✓	✓	2				\$99
3-D Cad			✓	✓	✓	✓	✓	✓	✓	2				\$495
Mini Cad			✓	✓	✓	✓	✓	✓	✓					\$495
Landcadscape Design	✓			✓	✓	✓	✓	✓	✓		4			\$29
Stratavision			✓	✓	✓	✓	✓	✓	✓	4				\$745

NOTE: Sample data. Due to changing computer configurations and pricing, you will want to verify all information.



Activity 2

Low Cost CAD Applications

The main purpose of this activity is to get you started using CAD. We have selected 1 low cost and relatively simple program for each of the most common computer hardware platforms (DOS, MAC, and Apple II, C, or E) to help you in getting started. In this activity, a step by step set of procedures has been developed to help you develop the drawing which is shown in Figure 1.

This activity will require some basic computer skills, such as turning on the computer, learning how to use a mouse, formatting disks, and getting into software programs. If you're brand new to the wonderful world of computing, you'll want to get some basic orientation before starting to work with CAD.

Procedure

1. Obtain the software package. The packages which have been selected for this activity are listed below. They are either free or available for under \$100.

System	Software	Availability
DOS	Microcad	MORETECH
Macintosh	Key Cad Complete	Mac Connection 1-800-800-2222
Apple II	Accudraw	Kitchen Sink Software 614-235-5502

2. Boot the software and complete the steps of procedure for the system of your choice. If your school has more than one type of computer or CAD software, give them a try. Remember that flexibility and knowledge of a variety of technologies is a very desirable trait given the fast pace of technological change. Employers want people who can adapt and change as conditions change. One thing is for certain. Computers are going to change.



Integrated Activity Idea

Trace the history of the tools used to communicate ideas in industry for manufacturing industries including innovations in drafting up through CAD. What are the similarities between this "revolution" and previous ones? Is CAD something different from anything that's ever happened before in design and drafting? How? Explain.



Technology Idea

Research and discuss the implications of CAD on the revision of drafting standards (like ANSI) and skills required to work as a designer. What changes have been made to the standards as a result of CAD (line wt. requirements, lettering, arrows, etc.)? Will (or should) board drafting still be taught? Why, how, and how much?

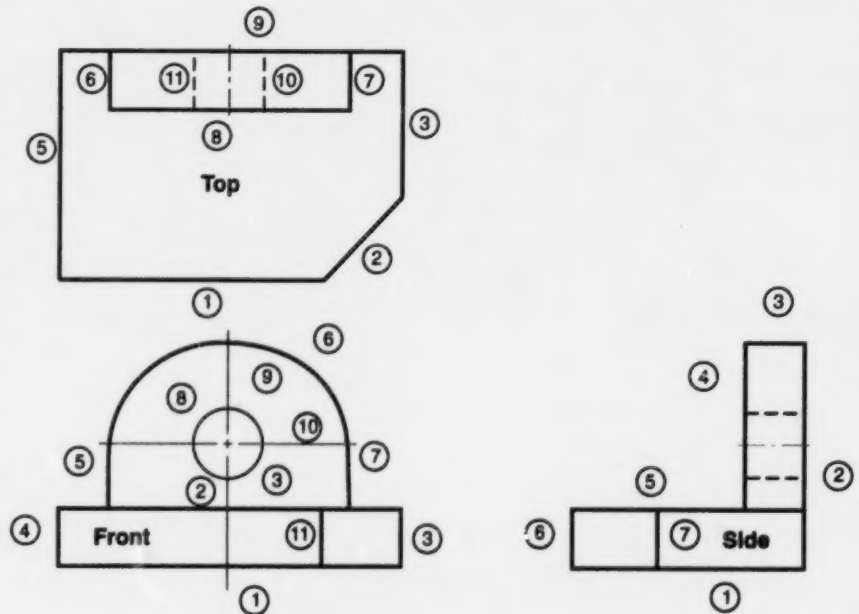


Figure 1 - CAD Drawing

MicroCAD - DOS Platform

1. Turn on your machine and get to the C>: Type CD/MICROCAD to enter the Microcad directory.
2. At the C:\MICROCAD> directory, type MICROCAD and press [ENTER].
3. You will be greeted with the MICROCAD welcome screen. Click the left mouse button to enter the drawing screen.
4. Next, click  GRID Icon (grid will be at 1/8" scale). Click GRID to remove grid.

Top View

1. Click  LINE Icon and begin drawing top view at the lower left hand corner of the top view and continue counter-clockwise until lines 1-9 are completed (notice room should be provided for dimensioning).
2. Click  HIDDEN LINE Icon and draw lines 10 and 11.



3. Click  ABC icon and type number 11, TOP. Center TOP by clicking icon, and clicking cursor on TOP; hold down and move.
4. Click  LINE icon to dimension drawing. Click  ABC icon to enter dimensions.
5. Click  icon to move dimensions into the desired position.
6. Click  ARROW icon to enter arrow on each side of the dimension line (notice  ARROW icon is the same as hidden line icon).

Front View

1. Click  SQUARE icon starting at lower left corner of the drawing and moving counter clockwise until lines 1-4 are completed.
2. Click  LINE icon to draw line 5.
3. Click  CIRCLE icon to draw circle 6, then click  SEMI-CIRCLE icon to delete lower half of circle.
4. Click  LINE icon to complete line 7.
5. Click  CIRCLE icon to draw circle 8.
6. Click  LINE icon to draw center 9, 10, and 11.
7. Click  ABC icon to type number 12, FRONT. Click  icon and place cursor on FRONT, hold and move to desired position.
8. Click  LINE icon and  ABC icon to enter dimensions. Click  icon and place cursor on dimension, hold and move to desired position.

Side View

1. Click  LINE icon starting at lower left corner and moving counter clockwise until lines 1-7 are completed.
2. Click  HIDDEN LINE icon and enter lines 8, 9, 10.
3. Click  ABC icon and type number 11, SIDE. Click  icon and place cursor on SIDE, hold and move to the desired position.
4. Click  LINE icon to dimension drawing. Click  ABC icon to enter dimensions. Click  icon to move dimensions into the desired position.



Integrated Activity Idea

Describe how CAD and various similar programs such as Freehand, Typestyler, paint programs, digitized clip art, electronic photography, etc. are affecting the art world. Are the changes generally positive or negative? Do they enhance or impede creativity.

- Click  ARROW icon to enter ARROW on each side of dimension line.

Additional Instructions/Aids

 Icon to pick-up object

 Icon to delete object.

By pressing  directions pre-located.

To print instructions type C:\MICROCAD then at the C:\MICROCAD> prompt enter COPY_MICROCAD.DOC_LPT1. This assumes that your printer is attached to your first parallel port.



Integrated Activity Idea

Discuss CAD from the economic point of view. What are the advantages and disadvantages for industry? Include a consideration of computer integrated manufacturing (CIM) in your analysis.

Key CAD Complete - Macintosh Platform

Getting Started

- Boot up machine. Click on Key CAD Complete.
- Pull down the LAYOUT menu and drag the cursor to GRID. Then select GRID SPACING (set at 1/8" or .125).
- Pull down the WINDOW menu and drag the cursor to TOOLBOXES and then select DRAW (notice the lower left corner of the screen). A new menu of icons has appeared.
- Pull down the WINDOW menu again and again and drag the cursor to TOOLBOXES and select EDIT, DRAG, SNAP, DIMENSION, and POSITION INFO. (Notice the remainder corners of the screen). A new menu of icons has appeared.

Top View

- Click the  LINE icon and begin drawing top view at the lower left hand corner of the top view moving counter clockwise until lines 1-8 are completed.
- Pull down the LAYOUT window and drag the cursor to LINES, then select TYPES.
- Click on CENTER LINE, ENTER, OK and draw line 9 (notice to align center line use arrow or cursor and hold down the mouse button on the corner of the highlighted line to lengthen or shorten lines).
- Repeat the process using HIDDEN LINE to enter lines 10 and 11.
- Click  DIMENSIONS icon and enter dimensions for drawing.
- Click  CAPTOL A icon to type top.



Front View

1. Click  LINE icon and begin drawing front view at the lower left hand corner of the front view moving counter clockwise until lines 1-4 are completed.
2. Click  LINE icon to draw lines 5 and 11.
3. Click  SEMI -CIRCLE icon to draw semicircle 6, then click LINE icon to complete line 7.
4. Click  CIRCLE icon to draw circle 8.
5. Pull down the LAYOUT window and drag the cursor to LINES, then select TYPES.
6. Click on CENTER LINE, ENTER, OK and draw lines 9 and 10 (notice to align center line with arrow or cursor and hold down the mouse button on the corner of the highlighted line to lengthen or shorten lines).
7. Click  DIMENSION icon and enter dimensions for drawing.
8. Click  CAPITOL A icon to type top.

Side View

1. Click  LINE icon starting at lower left corner and moving counter clockwise until lines 1-7 are completed.
2. Pull down the LAYOUT window and drag the cursor to LINES, then select TYPES.
3. Click on the HIDDEN LINE to enter lines 8 and 9 (notice to align center line with arrow or cursor and hold down the mouse button on the corner of the highlighted line to lengthen or shorten lines).
4. Click on CENTER LINE, ENTER, OK and draw line 10.
5. Click  DIMENSIONS icon and enter dimensions for drawing.
6. Click  CAPITOL A icon to type top.



Integrated Activity Idea

Do an ergonomic analysis of extensive computer use on human health. Include carpal tunnel syndrome, posture, electromagnetic frequency exposure, keyboard layout, etc. What do you think the long term effects will be? What do the health care professionals say? You may wish to interview someone in addition to your reading.



Integrated Activity Idea

Have the math teacher explain the mathematics of CAD including bezier curves, matrix algebra, and algorithms used for wire frame and solid modeling systems.

Accudraw - Apple II Platform

Getting Started

1. Boot up machine. Determine if accudraw is on, and select the main menu.
2. Select "FILE" then OPEN STYLE" then "ENGLISH" for this exercise. Select "TITLE BLOCK" for layer.
3. The middle window will ask for a name for your drawing. Enter a name you desire (notice: letter, numbers, and periods are all acceptable) then press enter.
4. A drawing will appear showing 3 possible borders, select "BORDER 3."
5. If all information is correct select "DO IT."

Top View

1. Click  LINE icon and begin drawing top view. At the lower left hand corner of the top view counter clockwise until lines 1-8 are completed (notice room should be provided for dimensioning).
2. Click  SYMBOL UNDERLINE icon and enter 9, 10 and 11.
3. Click  TEXT icon and type number 11, TOP. Center TOP by clicking icon, and clicking cursor on TOP, hold down and move.
4. Click  LINE icon to dimension drawing. Make sure  SYMBOL is solid, not dashed. Click  TEXT icon to enter dimensions.
5. Click  SYMBOL icon, type number 19 to enter arrow on each side of the dimension line.

Front View

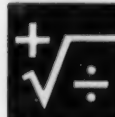
1. Click the  LINE icon, the  SYMBOL icon to change to dash line, and draw 2 reference lines.
2. Click  SQUARE icon starting at lower left corner of the drawing and dragging prompt to other end of desired square.
3. Click  SQUARE icon to draw line 5 and to change back to line.
4. Click  CIRCLE icon to draw circle 6, then click  ERASE icon to delete lower half of circle.



5. Click LINE Icon to complete line 7.
6. Click CIRCLE Icon to draw circle 8.
7. Click TEXT Icon, and move cursor to the desired location, then type number 12, FRONT.
8. Click LINE Icon and TEXT Icon to enter dimensions at the desired location.

Side View

1. Click LINE Icon starting at lower left corner and moving counter clockwise until lines 1-7 are completed.
2. Click LINE Icon and enter lines 8, 9, 10.
3. Click TEXT Icon, move cursor to the desired location and then type number 11, SIDE.
4. Click LINE Icon to dimension drawing at the desired location. Click TEXT Icon to enter dimensions.
5. Click SYMBOL Icon, type number 19, and enter ARROW on each side of dimension line.



Integrated Activity Idea

Have the computer science teacher explain the basic features of CAD programming. How do they do it? What will be the effect of such developments as "fuzzy logic" and voice input on CAD?

Materials Needed

MicroCAD (DOS)
KeyCAD Complete (Macintosh)
Accudraw (Apple II)
DOS compatible computer
Apple II computer
Macintosh computer

Activity 3

CAD Scavenger Hunt

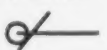
The purpose of this activity is to assist you in becoming familiar with the basic CAD drawing commands which are present in your software package. To complete the activity, you will need to use your software manual and the software itself. Actually it is best to use both.

1. For each feature, indicate whether or not the software is capable of completing the "Desired Operation." Indicate this by placing a ✓ in the Yes/No box.
2. Next, in the space to the right of the checkoff area, indicate the F-Key command, keystrokes, or other procedures required to accomplish the operation. Be sure to provide enough information so you can follow it later on when you need it. Remember, documentation is only as useful as it is clear and complete (ever seen documentation that was poorly done?).
3. If your software package has additional features, include these in the space provided at the end of the prepared list.

Name: _____

Computer Platform: _____

Software Program: _____

Desired Operation	Feature Checkoff		Procedure reqd. to accomplish (keystrokes, F-keys, etc.)
	Yes	No	
1. Create Line 	☐	☐	_____
2. Create Fillet/Round 	☐	☐	_____
3. Create Arc 	☐	☐	_____
4. Circle/Tangent 	☐	☐	_____
5. Parallel/Perpendicular Lines 	☐	☐	_____
6. Angle/Radian 	☐	☐	_____
7. Dimensions/Section Lines 	☐	☐	_____
8. Create Hidden Lines 	☐	☐	_____
9. Trim/Erase 	☐	☐	_____



10. Create Circle

☐☐

11. Create Point

☐☐

12. Create Spline

☐☐

13. Chamfer

☐☐

14. Change Line Type

☐☐

15. Delete/Erase

☐☐

16. Mirror

☐☐

17. Copy

☐☐

18. Move

☐☐

19. Drawing Layers

☐☐

20. Multiple Viewpoint drawing

☐☐

21. Change Line Color

☐☐

22. Change Line Thickness

☐☐

23. Draw in 2D

☐☐

24. Draw in 3D

☐☐

25. Rotate Object on an Axis

☐☐

26. Display Cartesian Coordinates

☐☐

27. _____

☐☐

28. _____

☐☐

29. _____

☐☐

30. _____

☐☐

Materials Needed

CAD software - Your choice

Software manuals

Computer

Activity 3

Putting it to use

This activity is designed to put your documented scavenger hunt information to use in creating an actual drawing. In this activity, the sequence of steps is being provided. In the next activity a more complicated drawing will be used and it will be up to you to determine the sequence of steps.

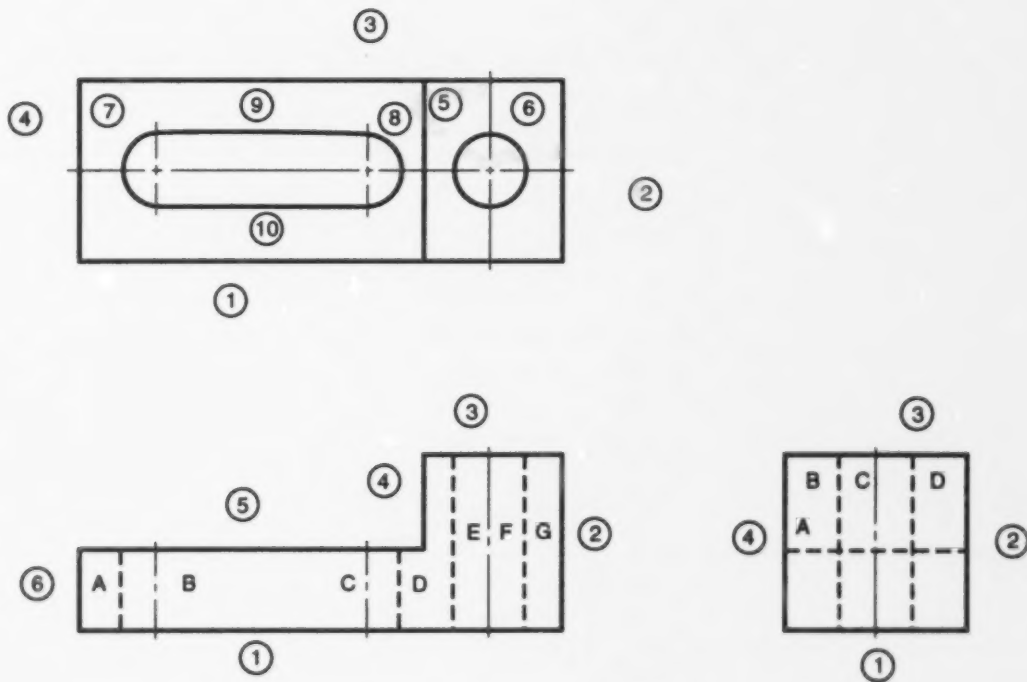


Figure 2 - CAD Drawing

Top View

1. Create lines 1-5. You may do these as individual lines or create a rectangle for 1-4.
2. Create circle 6. You will need to indicate a center point and a diameter of the circle. Depending on the software, you may have the option of keying in coordinates or selecting the position with your cursor.
3. Next create arcs 7 and 8. As with the circle, you may have several optional procedures depending on your software. One way of doing



this operation is to create two circles which you will trim later (after lines 9 and 10 have been drawn).

4. Create lines 9 and 10. Make them tangent to arcs (or circles) 7 and 8. Next trim as necessary to create a smooth slot shape.
5. Add center lines.

Front View

For this exercise we will create a top view in much the same manner as would be used to create a mechanical drawing by hand. You should be aware, however, that most CAD packages have some type of transform which automatically creates multiple views from a single view. This is one of the real advantages of CAD over traditional drafting. For this activity we will continue with creating individual view separately. You may wish to experiment with the transform tools if your software has it.

1. Create the overall outline of the front view (lines 1-6). As with the top view there will be several ways to accomplish this. In any case make certain your front view projects accurately from your top view.
2. Create hidden and center lines for A-G.

Side View

1. Create lines 1-4. You may do this by using individual lines or a rectangular function.
2. Create hidden and center lines for A-D.



Integrated Activity Idea

If you were to become a Technology Education teacher, how would you teach drafting and design to middle school or high school students? Should they begin with CAD or is it still important to teach them the basics of board drafting? Debate the 2 sides of the issue.

Materials Needed

CAD Software - Your choice
Computer System
Output Device

Activity 4

Sequence Procedure Development

This activity consists of producing the drawing shown in Figures 3 and 4. It will be up to you to determine the sequence of steps and the types of operations you wish to use to make the drawing. Draw the drawing and show all dimensions.

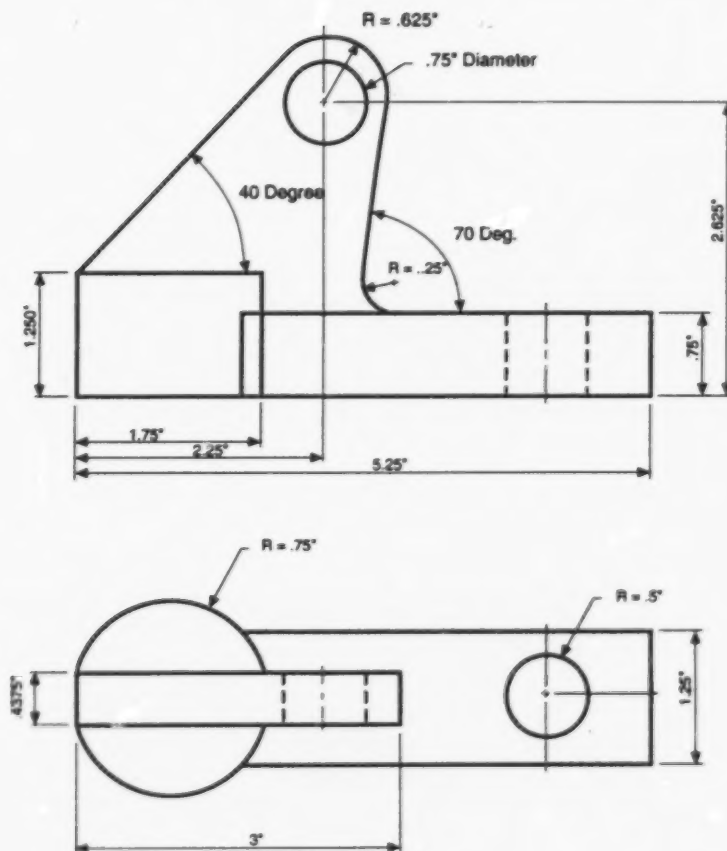


Figure 3 - Front View & Top Views



Activity 5

Going Further with CAD

There is much more that you can do with CAD. At one level, there is the matter of becoming more proficient with CAD software. There are many complex types of drawings which can be completed and which you'll want to learn how to do. These take hours (and sometimes) years of practice.

With the development of modern computer integrated manufacturing (CIM) software, CAD has become even more important. Think about it for a minute. When drawings are done on a CAD system, the computer isn't "remembering" or "thinking about" things in visual form. Remember that everything that a computer does boils down to the manipulation of binary data. In other words, it's all done with ones and zeros. So CAD files are really not visual images. They're data sets.

So, what does this mean for CIM? CIM software systems are designed to combine manufacturing data sets (like NC code, robotics programs, PLC data, and even business databases) with CAD. What happens is that special software is used to change the CAD data set to something else. One example is SMARTCAM which is software used to convert CAD data sets into NC code. In Activity 3 of Performance Standards TAM 14 - Mass Production there are instructions for writing NC code manually. It is much more cost efficient and accurate to simply convert an existing CAD data set to NC through software. Why develop another data set (in this case NC) when one already exists which can be translated for use?

Below are five suggested activities which take the use of CAD further. Give them a try and remember that many businesses and industries are using CAD. Skills in CAD could be your front door to a future career!

- Do a complete set of drawings for a house. Include a floor plan, foundation plan, roof plan, wall section, electrical plan, plumbing plan, etc. Use the various layers which are present in most CAD systems for doing these various plans. Dedicate one layer to Smart House technology (see Performance Standards TAM 6 - Smart Houses by Mike Maxwell for additional information).

- Do a mechanical drawing of an object which includes at a minimum 1 spur gear and 1 rack and pinion gear (a transmission system). Use the copy and rotate command to generate multiple teeth from a single tooth.

- Obtain a conversion program to convert CAD to NC code (SMARTCAM is one such package). Convert the data set and then run the NC program on an NC mill. (Note that these conversion packages are increasingly becoming more affordable. However, you could also get exposure by visiting a manufacturing company to see a demonstration of the conversion process).

- Develop a library of drafting symbols for architectural, mechanical, piping, furniture, screws, welding, PC board layout, electronic, electrical, etc. Store for later use on various CAD drawings.

- Configure software to interface with various output devices such as a laser printer, a deskjet printer, a dot matrix printer, a plotter, or a direct interface with the stepper motors of an NC mill.

Assessment

Scoring Rubric for Activity 4 - Assignment Sheet 4

Performance Standard	Wgt %	Exemplary 2 pts.	Acceptable 1 pt.	Not Yet Acceptable 0 pts.	Sub total
I. Creative Thinker					
Identify typical applications in which CAD are effectively used in industry, such as drafting, designing, manufacturing, and material/design analysis.	x.5	Can identify and discuss three industrial applications where CAD is effectively used.	Can identify and discuss one industrial application where CAD is effectively used.	Can not identify and discuss any industrial applications where CAD is effectively used.	.5 x 2 = 1
Identify and discuss typical industrial areas that use CAD, including architectural, mechanical, and process flow.	x.5	Can identify and discuss three industrial areas where CAD is used.	Can identify and discuss one industrial area where CAD is used.	Can not identify and discuss any industrial areas where CAD is used.	.5 x 2 = 1
II. Critical Thinker					
Speculate the future of CAD, including its changing role in industry, hardware, and software innovations of the future.	x.5	Student discusses the future of CAD for all components of the performance standard.	Student discusses the future of CAD for one of the components of the performance standard.	Student does not discuss any future trends of CAD.	.5 x 2 = 1
Discuss the advantages and disadvantages of CAD vs. traditional drafting methods.	x.5	Student discusses six total viable advantages and disadvantages of CAD vs. traditional drafting.	Student discusses two total viable advantages and disadvantages of CAD vs. traditional drafting.	Student does not discuss any viable advantages / disadvantages of CAD vs. traditional drafting.	.5 x 2 = 1
III. Contributing Citizen					
Practice all safety procedures when interacting with CAD and when using the output devices associated with CAD.	x.5	Student successfully and safely completes all CAD activities without incident.	Student successfully and safely completes all CAD activities with only a potential incident.	Student completes CAD activities, but with single or multiple actual incidents.	.5 x 2 = 1
IV. Self-Directed Learner					
Identify and use various CAD software packages across the major computer platforms (Macintosh, DOS-Compatible, Apple IIE).	x1	Student successfully uses CAD software from all three platforms for Activity 4.	Student successfully uses CAD software from two of the three platforms for Activity 4.	Student does not use any software from any platform.	1 x 2 = 2
V. Problem Solver					
Develop a design for and solve problems related to a simple CAD project.	x1	Student successfully solves Activity 4 drafting problems with no assistance from teacher.	Student solves problems with two or less assistance situations from teacher.	Student either does not solve problems or constantly needs assistance.	1 x 2 = 2
Solve problems related to producing a CAD project, including software and hardware problems.	x1	Student successfully solves software problems with no assistance from teacher.	Student solves problems with two or less assistance situations from teacher.	Student either does not solve problems or constantly needs assistance.	1 x 2 = 2
VI. Effective Communicator					
Communicate orally, visually, and/or in writing the principles of a CAD system.	x1	Student can correctly communicate the theories of CAD system and/or activity.	Student can communicate the theories of CAD system and/or activity with 2 errors or less.	Student cannot correctly communicate the theories of the CAD system and/or activity.	1 x 2 = 2
VII. Quality Producer					
Create a simple CAD project that is correct per ANSI-Y14a drafting standards.	x2	Student correctly completes Activity 4 with no ANSI errors.	Student completes Activity 4 with 2 ANSI errors or less.	Student's work is not compatible with ANSI standards.	2 x 2 = 4
Define those practices and terms used in CAD software, such as basic drawing, editing, and manipulating, saving, and printing/plotting.	x1	Student correctly defines all practices and terms used in the CAD software.	Student defines all practices and terms with 2 errors or less.	Student defines all practices and terms with more than 2 errors.	1 x 2 = 2
VIII. Technical Foundations					
Identify the various foundation skills for different career options in CAD.	x.5	Student correctly defines three foundation skills for different career options in CAD.	Student correctly defines one foundation skill for different career options in CAD.	Student does not identify any foundation skills for different career options in CAD.	.5 x 2 = 1

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Total: 20 out of 20 Possible



Additional Assessment Items

Short Answer Essay Questions

1. Before using a floppy disk for data storage, what operation needs to be performed?

2. Entities can be described as _____, _____, _____ on a CAD system.
3. CAD stands for _____.
4. The printer or plotter prints the drawing displayed on the screen called a/an _____ copy.
5. List and discuss the major advantages and disadvantages of CAD systems over traditional board drafting.
6. Explain how CAD data are useful in manufacturing. How can they be converted and used by automated machine tools?
7. Identify and discuss 5 major occupational areas which use CAD systems. Do some of these surprise you? Why?

CAD Tech-Folio

Develop a CAD Techfolio. Include:

- Samples of CAD printouts
- The results of your CAD Scavenger Hunt
- Steps of procedure you prepared for completing a drawing
- Documentation information about CAD conversion for use in CIM systems
- Samples of correspondence with CAD, CIM and computer vendors
- CAD drawings for products developed in other TAMS (smart house layer - TAM 6, 2 way vise-TAM 13, bridge designs, TAM 15, etc.)
- Any templates or quick reference sheets used with drawing
- Up to date printout of CAD software, recommended vendors, contact information, costs, etc.
- Test results

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**Performance Checklist for Activity 3 - Putting it to Use****4 = Excellent (student successfully completes activity & displays mastery of subject/content)****3 = Good (student completes activity with good quality)****2 = Needs Improvement (student completes activity without demonstrating mastery of subject matter or activity performance requirements)****1 = Not Acceptable (student does not yet successfully complete the activity, needs additional work)**

1. Student displays mastery of general computer functions (power up, manipulation of keyboard, mouse, diskettes, etc.)	4	3	2	1
2. Student displays mastery of software functions (operating systems/ CAD-specific maneuverability).	4	3	2	1
3. Student displays mastery of ANSI drawing standards (line thickness, line types, dimensioning, etc.).	4	3	2	1
4. Student displays mastery of orthographic (3rd angle) projection standards.	4	3	2	1
5. Student demonstrates correct "drawing in proportion" skills.....	4	3	2	1
6. Student solves all problems in an effective and efficient manner. ...	4	3	2	1
7. Student demonstrates using the "most efficient" CAD tool for the task (using the rectangle tool rather than the line tool to draw a box). ..	4	3	2	1
8. Student properly (and periodically) saves all work and makes backup copy.	4	3	2	1
9. Student successfully completes project.	4	3	2	1
10. Student demonstrates mastery of printing/plotting final copy.....	4	3	2	1



Name _____

Affective Self and Peer Assessment

For each of the criteria, assign a rating to each member of the class (including yourself) on a scale of 4 - 0
(4 = excellent, 3 = good, 2 = average, 1 = poor, 0 = unsatisfactory.)

	Student A	Student B	Student C
Initiative (ability as a self-starter, self motivated)			
Use of time (consistently on task, productive, efficient)			
Reliability (regular attendance, carry tasks through to completion)			
Work quality (tasks and operations were well done)			
Idea quality (good problem solving skills and ideas)			
Ability to work with others (ability to share tasks, contributing team member)			
Overall knowledge of CAD			
TOTALS			

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By Joe Scarcella & Rod Custer

Instructor Resource

Design in the Electronic Age

Content Outline

1. Basic Definitions
2. CAD Hardware
 - Input devices
 - Output devices
 - Computer systems
3. CAD Software
 - For Various Platforms
 - Features
4. Advantages/Disadvantages of CAD
5. Coordinate Systems
 - Absolute
 - Relative
 - Polar
6. Operations with CAD
 - Dimensioning
 - Entities
 - Layering
 - Zooming & Panning
7. CAD/CAM
8. Careers in CAD

sources

Books

Bertoline, G.R. (1988). *Fundamentals of CAD*. New York: Delmar Publishers, Inc.
 Brown, W. (1984). *Drafting for Industry*. Illinois: Goodheart-Wilcox Co., Inc.
 Cooper, R.E. (1990). *Introduction to versa cad*. Ohio: Merrill Publishing Co.
 Duelm, B.L. (1989). *Computer aided drafting: fundamentals and applications*. IL: Goodheart-Wilcox Company.
 Fuller, J.E. (1988). *Using VersaCad*. New York: Delmar Publishers, Inc.
 Keedy, H.F. (1988). *An Introduction to CAD using CADKEY*. Boston: PWS-Kent.

Additional Resources

- Film slides/ Films/ Video presentations.
- Field trip to an actual tool and die or manufacturing plant utilizing CIM/ CAD/CAM to identify components and design features.
- Guest speakers from industry or technical schools.

Magazines

The Technology Teacher

School Shop

Technology Innovations and Entrepreneurship for Students

Hearlthy & Company Drafting and Design Equipment, Graphic Arts Supplies Catalog 1800-622-1000

MacWarehouse

Global computer supplies 1800-277-1246

Misco computer products 1800-876-4726

Individual Contact for Apple/Laser operations:

Larry Lake on Moretech: llake1@services.dese.state.mo.us
 (314)898-5147



Glossary of Terms

CAD - Computer Aided Design, the use of a computer to assist in the process of designing a part, circuit, building, etc. Computer Aided Drafting, The use of a computer to assist in the process of creating, storing, retrieving, modifying, and plotting a technical drawing.

CAD/CAM - A technology that links computer-aided design with computer aided manufacturing. Design information is communicated directly to the machine tool by computers.

CIM - Computer Integrated Manufacturing, The use of computers to control both the business and production aspects of a manufacturing facility.

CPU - Central processing unit, the logic function part of the computer.

Cursor - Display that represents the current working points on the screen.

Cut - Removes selected objects or text from a document and puts them on the clipboard.

DOS - The disk operating system in the computer for IBM or IBM compatible computers.

Entity - A single drawing element such as a line, circle, or arc.

Hard copy - A printed or plotter copy of data or drawing.

Hard disk - A data storage device within the computer.

Input - Data entry into the computer.

Interface - The bridge between two parts of a system. For example, an optical sensor interfaces to a controlling computer to tell it whether or not there is a part waiting to be picked up.

Keyboard - Key pads similar to a typewriter for data input.

Main menu - A list of major commands that can be selected from to routines, and is displayed on screen.

Monitor - A CRT, or TV like screen for viewing work done on computer.

Mouse - A small input device moved on a flat surface that senses movement and moves the cursor on the monitor screen.

Output - Data leaving the computer to a printer or plotted, and monitors.

Printer - Prints a copy of the active CAD document.

Plotter - Device used to get a hard copy of graphic display using a dot matrix image.

Save - To keep on disk data that needs to be called back later.

Snap - A drawing aid that allows entered points to "snap" or move to the closest point of an imaginary grid.

Safety Factors

Students need to be reminded not to have liquids near the CAD system, to stay clear of moving printer or plotter parts, and to observe the proper respect of electrical plugs and wires.

- Basic electronic safety rules, shock hazard, etc.
- No food or drink in computer area.
- Proper posture will be stressed at computer station.
- Stay clear of moving parts on the plotter.

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Instructional Suggestions

Motivation

- Perhaps the most powerful motivational suggestion is to incorporate a competitive aspect; within the class, across classes, or even across schools.
- The state-wide competition during the MITEA's annual Technology Exposition Contest is a further motivational factor.
- Video materials about CAD activities.
- Post pictures and posters of high tech manufactured materials and equipment on the walls.
- Guest speakers who understand the design, manufacturing techniques, and engineering aspects associated with CAD.
- Field trips to local materials and processing facilities using CAD/CAM/CIM.
- Invite administrators, counselors, news coverage can all be used to heighten the motivation.
- Display CAD drawings on the bulletin board.

Prerequisite Information

- A basic working knowledge of drafting, terminology, and related skills.
- A simple understanding of the Cartesian coordinate system.

Demonstrations

- Start-up and shut-down of the computer system.
- Mouse and keyboard including F-keys.
- Setting parameters, units, bases, snap, etc.
- Storing and retrieval of drawings and files.
- Generating a drawing and its application.
- Printing and plotting hard-copy.
- Mechanical drafting and computer application.
- Interfacing classroom activities to the computer, such as spread sheets, CAD, CAM, CIM, graphics, etc.
- Use of camcorder.
- Understand that computer applications such as CAD can operate the machines which manufacture the product. CAD/CIM/CAM.

Academic Enrichment

- There are countless manufacturing related projects available for enrichment. Research papers, work procedure enhancements, and improvement methods are but of the possibilities.
- This TAM provides an excellent opportunity to reinforce basic skills in math, drafting, communications, typing, and problem solving.



Related TAMS

- The Introduction to Communication Technology Guide
 - TAM 3 CAD
 - TAM 4 Desktop Publishing
- 1990 Implementation Workshop TAMS
 - TAM 8 Desktop Publishing

Assessment/Evaluation Suggestions:

- Because of the importance of problem solving and the careful work required in CAD, it is suggested that the instructor weigh heavily the practical aspects of the TAM activities.
- Evaluate the projects design/sketch based on the design principles of form, function, and ease in manufacturing.
- Consider pre-test and post-test results in addition to the rating of the final projects taken by the student.
- Instructor observation of work habits and progress.
- Hard-copy turned in to validate competencies.

Important Note: Review the assessment items which are presented throughout the Performance Standards TAMS for ideas which can be adapted for this TAM. You should also refer to the Performance Standards Education Implementation Handbook for additional assessment examples and ideas.

Summary

The introduction to CAD has made tremendous progress in industry used for designing, drawing, and programming tools and equipment. This TAM discussed the tools of CAD, and how to get started.

In the years ahead, computer software designers will develop even more sophisticated CAD packages. In addition, more sophisticated packages will be designed to integrate CAD data throughout the entire manufacturing system through networked systems.